THE INSTITUTION OF PRODUCTION ENGINEERS JOURNAL

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FEBRUARY 1959

THE INSTITUTION OF

PRODUCTION ENGINEERS JOURNAL

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CONTENTS


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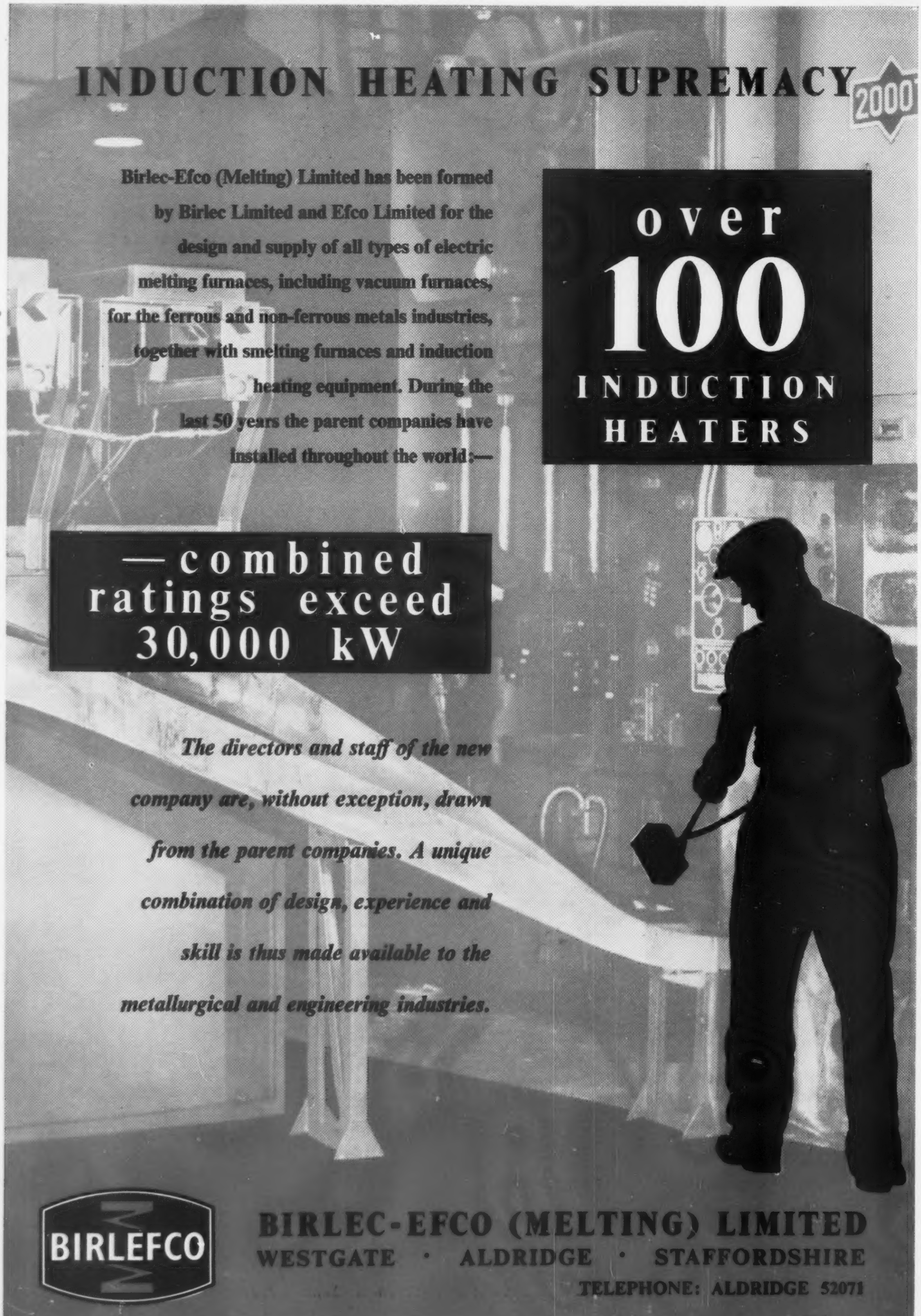
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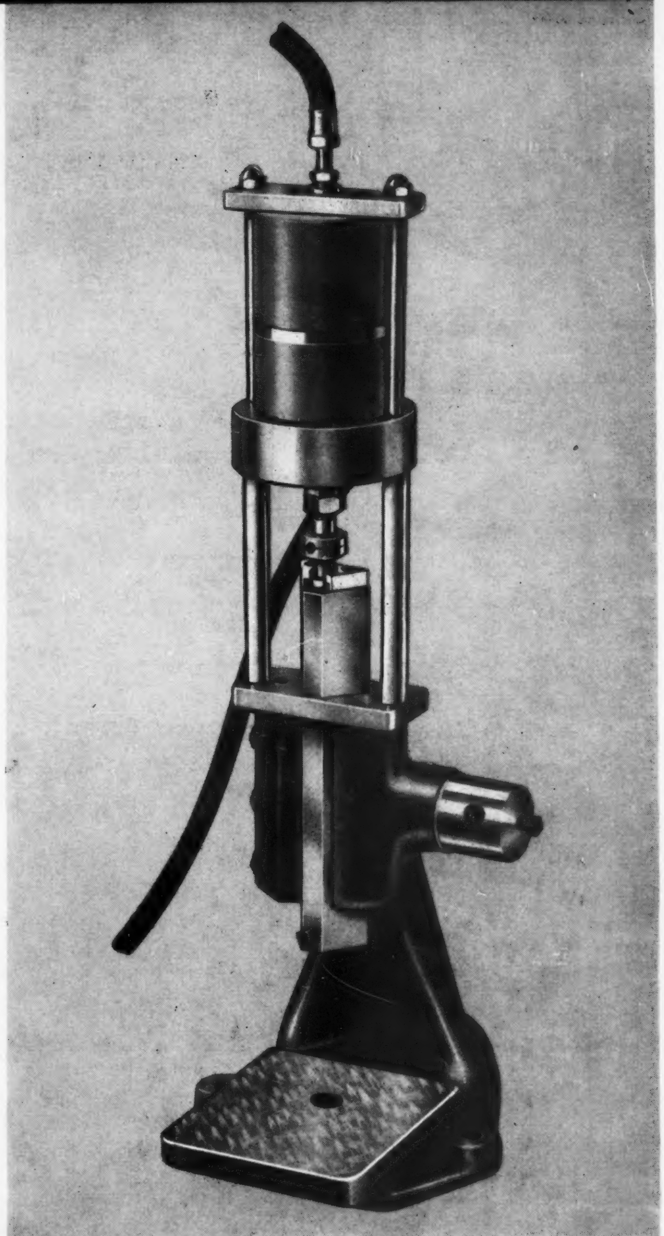

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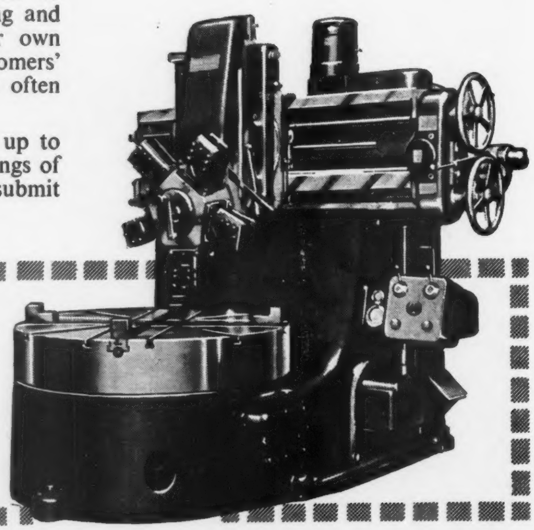

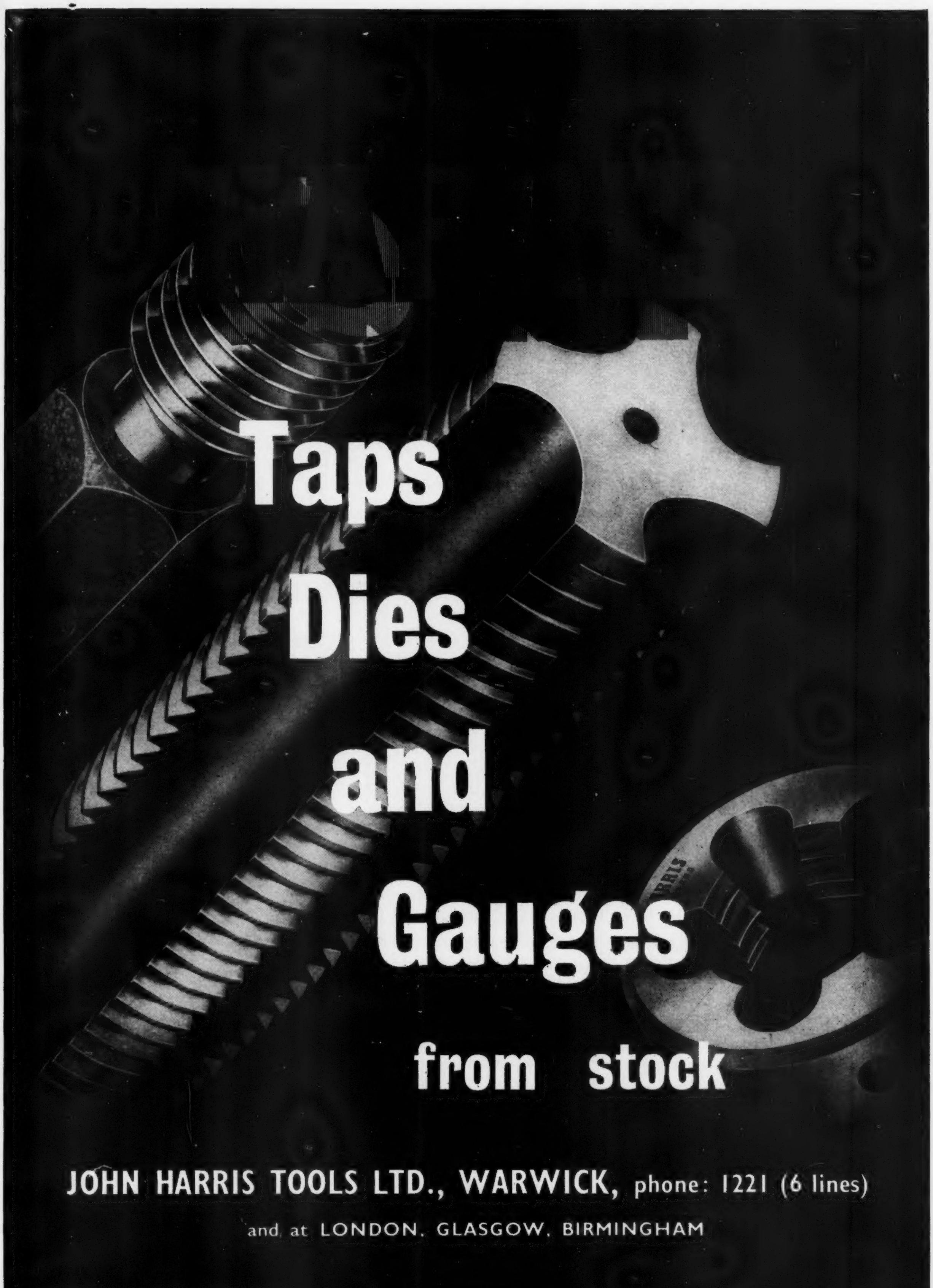
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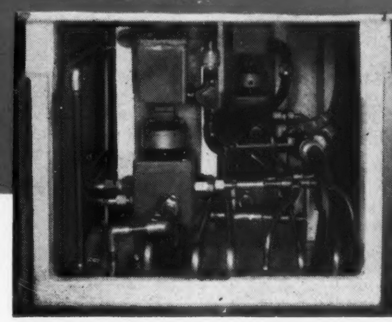

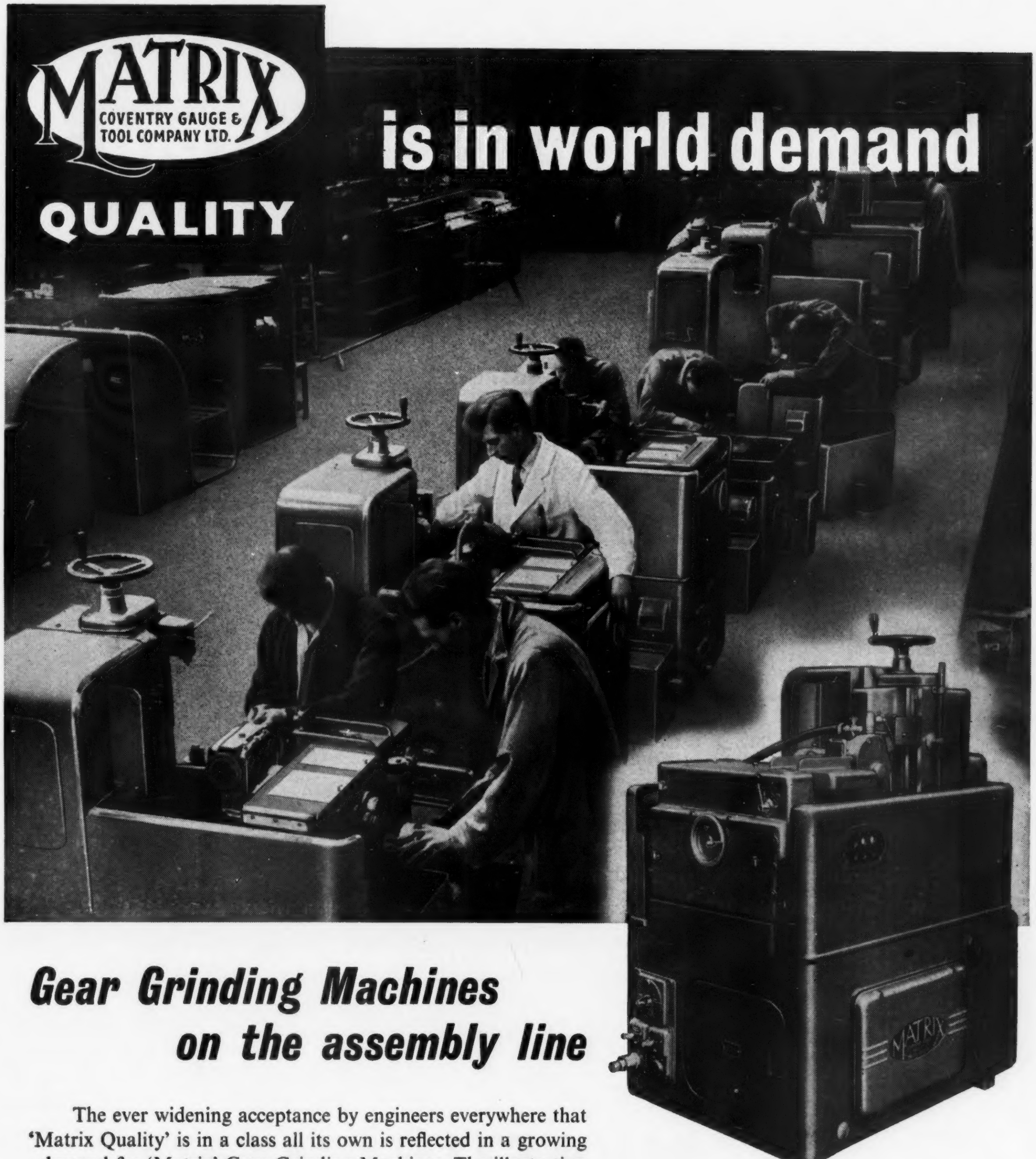

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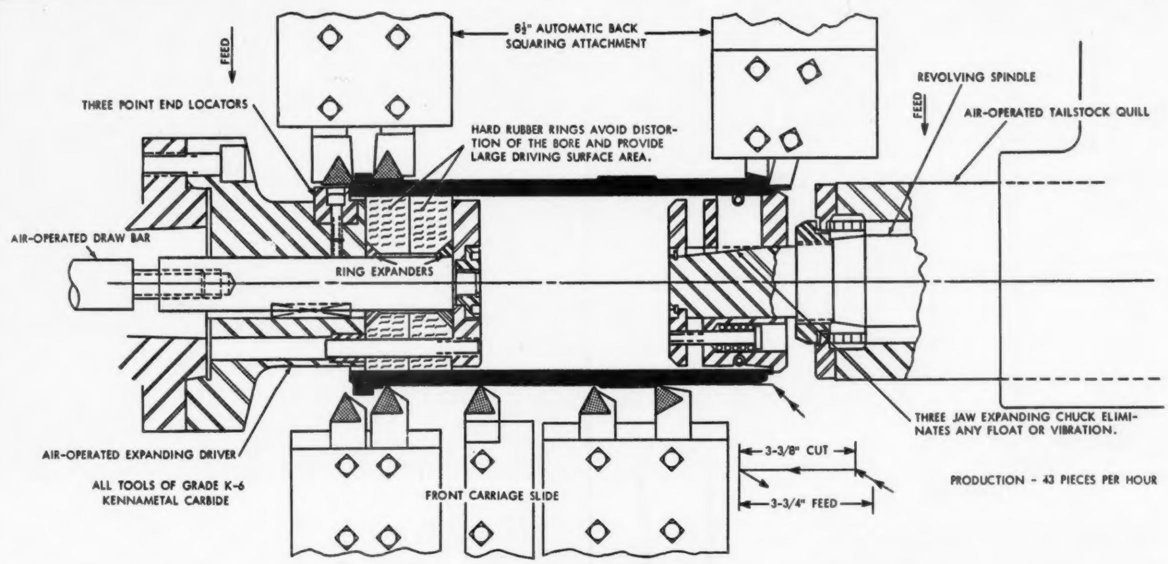

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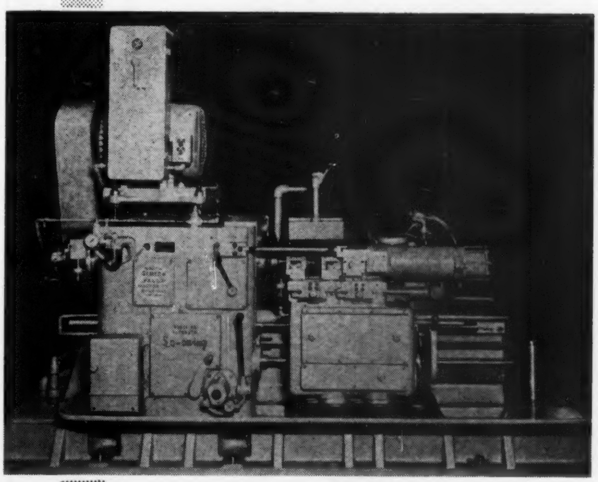

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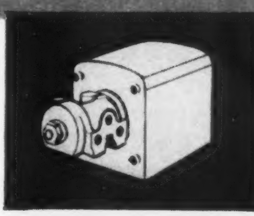

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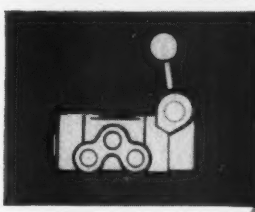

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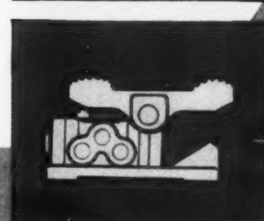

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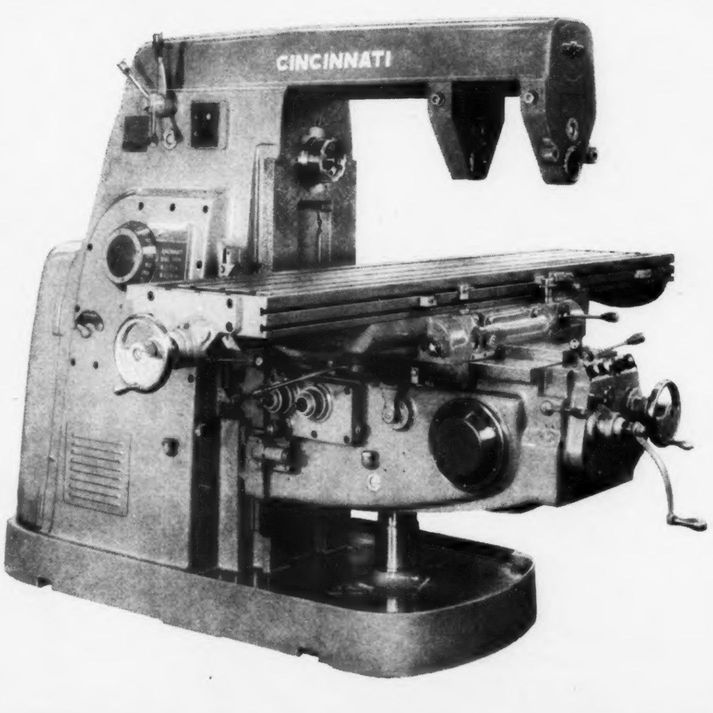
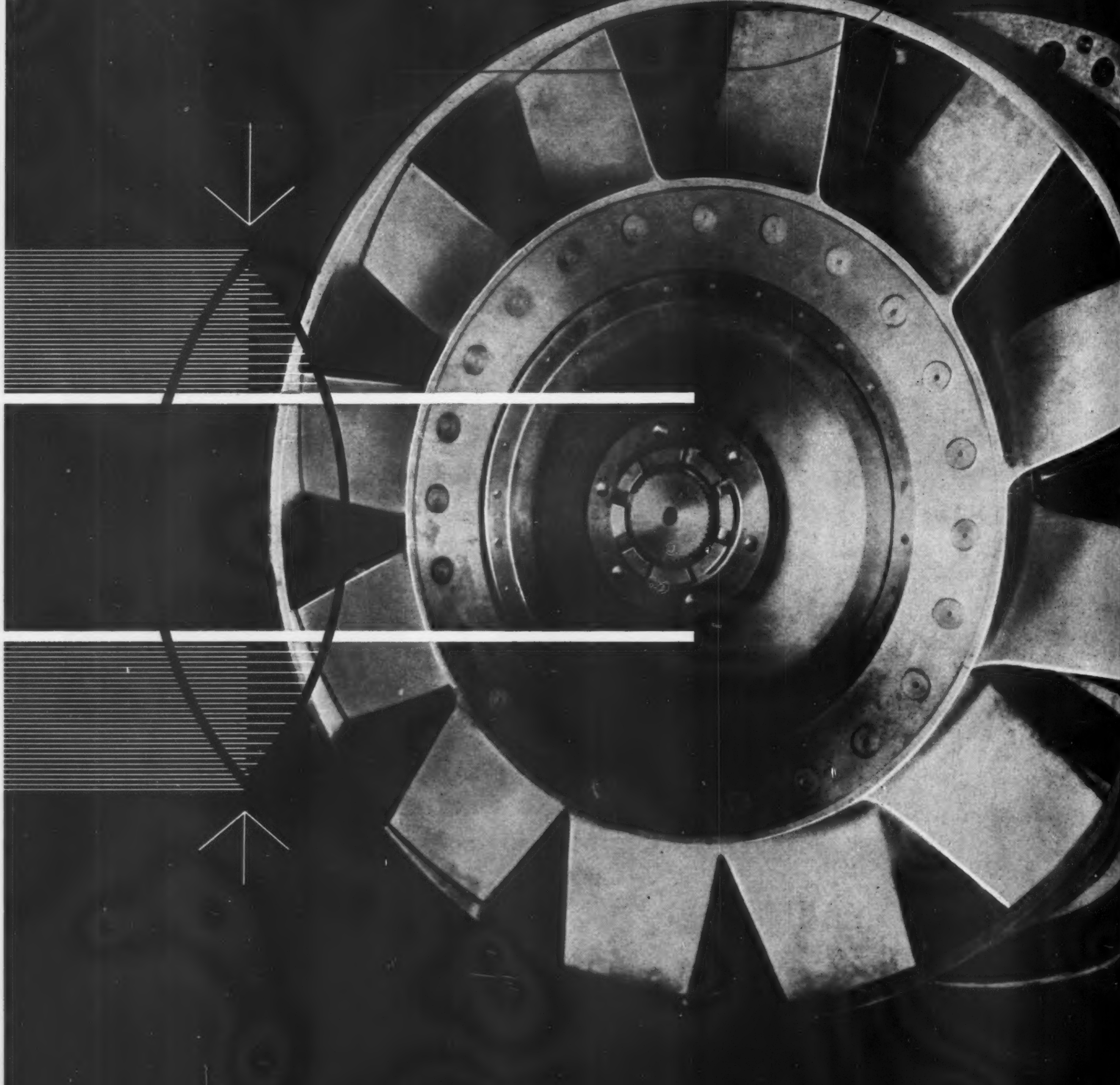

CINCINNATI

APL blower oil on s



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The crucial points of the high pressure CO_2 coolant circuit at Bradwell will be the blower shaft seals. Every minute of every working day Shell APL blower oil will guard these escape points—being continually pumped into the seals and bearings, led away, purified and recirculated.

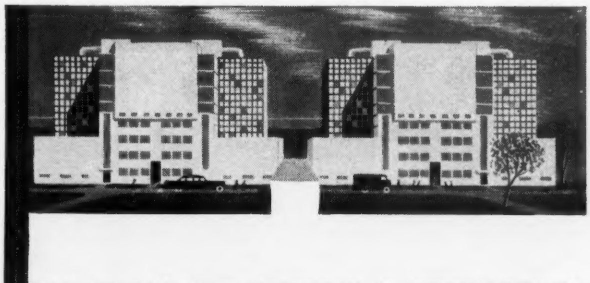
This very remarkable oil presents a two-way seal. Outwards, there is a minimum CO_2 loss as the oil has the lowest possible gas solubility. Inwards, in spite of the heat of the gas, oil vapour contamination is negligible thanks to the extremely low vapour pressure of the oil.

The research that went into APL blower oil is characteristic of the way Shell set about doing things. It was conducted at Shell's Research Centre at Thornton in close collaboration with the U.K. A.E.A. and the blower manufacturers. In the course of much fundamental research, a wide range of oils was subjected to vapour pressure and gas solubility tests in the laboratory. Selected oils from this range were used in the bearings and seals of a blower rig. In 1956, after four years of research, the finished product joined the Shell Atomic Power Lubricants range—marketed under the name of Shell APL 729. This oil has been in use at Calder Hall since the autumn of 1956.

The moral of the story is that Shell research is supremely applicational. The Centre at Thornton is always ready to work with even the most specialised sectors of industry to produce the right oil for the job. If you and your organisation have any major lubrication problem it pays to get in touch with your local distributor of Shell Industrial Lubricants.

The Research Story

Though the sealing action demanded of Shell blower oil is common in other industrial equipment such as hydrogen-cooled alternators, there were quite a few additional problems. It was necessary for the oil to have long life, low vapour pressure, low gas solubility, good thermal stability and high film strength —to be able to withstand high temperatures and to be resistant to all kinds of corrosive influences, including carbonic acid. The crux of the research was to combine all the above requirements into one oil, in order to minimise back diffusion of molecules which would contaminate the reactor.



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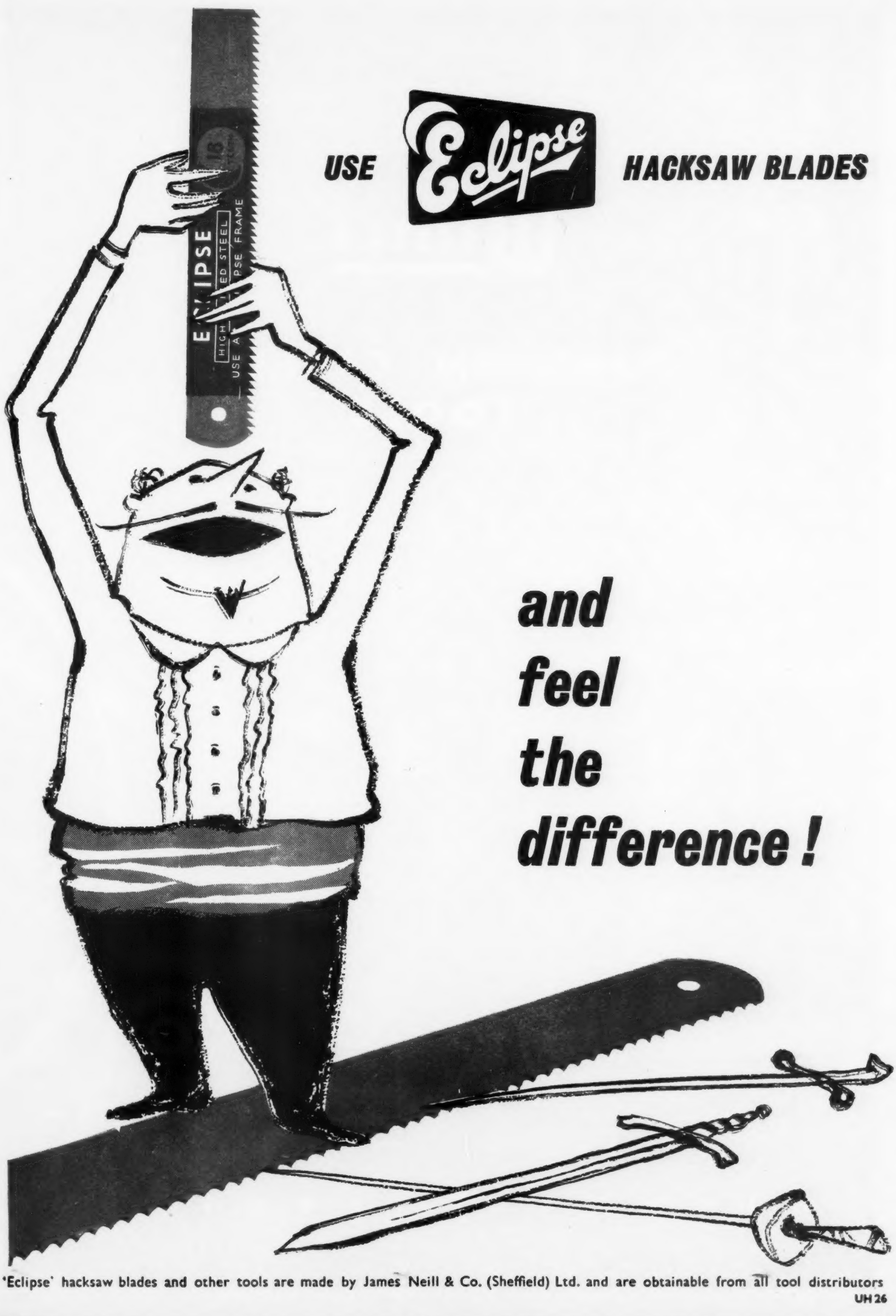
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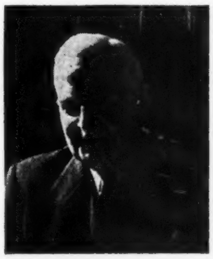
The Institution of Production Engineers Journal
VOL. 38 NO. 2 FEBRUARY, 1959

The European Common Market, the Free Trade Area, and the Production Engineer



by SIR CECIL WEIR
K.C.M.G., K.B.E., M.C., D.L.

Sir Cecil Weir is a Past President of the Institution; Chairman of International Computers and Tabulators Limited; and former Head of the United Kingdom Delegation to the High Authority of the European Coal and Steel Community. This Paper was presented to The Institution of Production Engineers in London, in December last, as The 1958 Sir Alfred Herbert Paper.

MAY I begin by saying how very glad I am to be here this evening and to have the opportunity of meeting again so many of my colleagues in this fine Institution, which continues to make such remarkable progress.

I have always regarded my association with the Institution as something that I have every reason to feel proud of, and I welcome opportunities like this of coming together with so many old friends.

As a Past President of The Institution of Production Engineers, I naturally feel it to be a very great honour to read to you this evening a Paper which bears the name of a former revered and distinguished President of the Institution, the late Sir Alfred Herbert. He was a great industrialist who did much to create the reputation which the British machine tool industry enjoys all over the world. The last time I saw Sir Alfred Herbert was in 1952, when I visited his Works in Coventry with a delegation of production engineers. Although then in his 86th year, he was still a dynamic, vigorous, purposeful figure. My colleagues and I were greatly impressed with the evidence of able management and organisation which we saw everywhere during the tour he had arranged for us of this famous Midlands factory.

It struck me then that the men who built this great business were not afraid of competition. They had that confidence in themselves, in their managing and organising capacity, in the skill of their designers and workpeople, and in the quality of their products, which typified the British industrialist in the latter half of the last century and the early part of the present century, and which won for the United Kingdom the premier place among the industrial nations of the world.

You might imagine from these remarks that I am regretting a past that is gone and inferring that we are no longer what we were. This is far from being the case. The achievements of the period I have spoken of were great and we have every reason to be proud of them. They made Britain for a time the industrial workshop of the world, the outstanding exporting and creditor nation during the greater part of a hundred years, a nation so sure of itself that it scorned to shelter behind customs duties and tariffs and which was not afraid to export also its technologies, its technicians, its know-how and its production methods.

And then came along two World Wars which successively revolutionised requirements and ideas, political as well as economic. From 1914 onwards we were in a new world in which other nations, forced, as enemies, as allies or as neutrals, to rely largely upon themselves, or to find new sources of supply, had to speed up their economic development, stimulated in some cases by the urgent needs of their own war requirements which cut through, for the time being, the difficulties of finance and inspired the genius of inventors. I think every one of you who was associated with any of the production ministries or with any of our great manufacturing companies during the War will recall how comparatively easy it was at that time to overcome the difficulties of finance. Things had to be done very quickly, and a great many business people had been brought into Government Departments. Many of the orthodox methods and regulations were no longer observed. In consequence, we were able to get on very quickly indeed. I think that this is perhaps one of the advantages that one gets from a war. There are advantages as well as disadvantages derived from these conflicts, and one of them is that a certain number of things can go ahead much more quickly than they could do under the ordinary conditions of peace. It is very desirable that in these days we should see that the speed at which we can work in war is translated also into peace conditions.

rapid changes

Circumstances and conditions changed very fast and, as a result, competition became fierce between the two Wars when a failure of statesmanship in all countries (I make no reflection on any particular country because this was a world state of affairs) delayed grappling with unnecessary unemployment and, in consequence, the flood of consumer demand was dammed; and after the Second World War competition was further stimulated when more enlightened political leaderships, having learned some of the lessons of history, and influenced also by the great developments which had taken place in the North American economies, and the prosperity they had brought with them, made it their principal aim to raise the standards of living of their people and to maintain a high level of employment.

It is this growth of competition, and the quality of that competition, which has so greatly changed the situation for Britain. It makes the achievements of the past forty years all the more meritorious and it makes the challenge of the future all the more vital and exciting.

I think, therefore, that I am entitled to say that the production engineer does really come into his own during this period. He can call the twentieth century his century. It is the evolution in management techniques, the growing availability of new tools of management in the factory, in the office and in all the ancillary operations of business—every one of which is a sphere for production engineering in the widest sense of its meanings and applications—the development of automatic and semi-automatic processes designed to increase the rate of productivity and lower the relative costs of production, which have opened the door of opportunity to the production engineer. He has become a key man, using and co-ordinating the techniques of the mechanical engineer, the electrical engineer, the civil engineer, and, indeed, those of all professional and technical grades which are associated with business and industry, and, bearing constantly and sensibly in mind the human repercussions which in any community must condition the timing and rate of progress, applying the new ideas as quickly as is practicable in every sector of the economy. It is during this period that the production engineer has played so important and growing a part in the achievements of industry—and, indeed, of agriculture also—and it is in the present and coming decades that his skills and methods will be so essential an element in the organisation of our factories and in the further and successful development of our production, and, as a consequence, in the trade that flows therefrom at home and overseas, in a highly competitive world economy.

Let us look for a few moments at some of the achievements of British industry in recent years. They cover a wide field and can be seen both in invention and its subsequent development and exploitation.

During the War quite a number of us in this room had a close association with some of these achievements. There was, for instance, that boon to civilisation, penicillin, which was a British discovery, and not only a British discovery but it was developed in Britain and it was brought in this country to the stage at which, in co-operation with our American friends who had greater resources than we had, it was more rapidly developed than would otherwise have been possible. There was radar. No one, of course, could possibly wish to deny that radar was a British achievement and that it is today one of the greatest services to mankind. There is nuclear energy, in the peaceful uses of which Britain has led the world. There is electric power, in which Britain is still the world's largest exporter of heavy electric equipment. There is television, in which many of the basic

Table I

UNITED KINGDOM TRADE WITH VARIOUS GROUPS IN 1957

	U.K. Imports 1957 from	U.K. Exports and re-exports 1957 to (£ million)	Population (1) (million)	U.K. Imports per capita £	U.K. Exports per capita £
Total U.K. Trade:	4,075·6	3,458·4	—	—	—
Europe	1,031·7	967·5	285·0(2)	3·6	3·4
Common Market and Free Trade Area..	872·8	833·5	191·5(2)	4·6	4·4
A. Common Market:	491·5	506·1	164·1	3·0	3·1
Belgium	60·2	81·3	8·9	6·8	9·1
Luxembourg ..	1·4	0·4	0·3	4·7	1·3
France	110·5	101·8	44·0	2·5	2·3
Italy	62·8	76·2	48·4	1·3	1·6
Netherlands ..	132·2	122·6	11·0	12·0	11·1
West Germany ..	124·4	123·8	51·5	2·4	2·4
B. Free Trade Area:	381·3	327·4	27·4	13·9	11·9
Austria	9·3	15·5	7·0	1·3	2·2
Denmark.. ..	114·6	87·5	4·5	25·5	19·4
Norway	64·1	72·7	3·5	18·3	20·8
Sweden	156·9	113·8	7·4	21·2	15·4
Switzerland ..	36·4	37·9	5·0	7·3	7·6
C. Rest of Europe:	158·9	134·0	93·5	1·7	1·4
Finland	73·0	37·9	4·3	17·0	8·8
Greece	8·1	19·2	8·0	1·0	2·4
Iceland	1·5	3·7	0·2	7·5	18·5
Portugal	16·5	23·3	8·9	1·9	2·6
Spain	38·6	27·5	29·4	1·3	0·9
Turkey	11·9	10·2	24·8	0·5	0·4
Yugoslavia ..	9·3	12·2	17·9	0·5	0·7
D. Commonwealth:	1,088·1	1,028·8	533·0	2·0	1·9
Australia ..	248·0	237·5	9·4	26·4	25·3
Canada	320·3	199·8	16·6	19·2	12·0
Ceylon	40·9	25·8	8·6	4·8	3·0
Ghana	19·6	38·5	4·8	4·1	8·0
India	157·6	177·5	392·4	0·4	0·5
New Zealand ..	183·4	140·7	2·2	83·4	64·0
Pakistan	25·7	34·6	84·8	0·3	0·4
South Africa ..	92·6	174·4	14·2	6·5	12·3
E. Other selected British Territories:	329·2	318·4	74·0	4·4	4·3
Brit. Guiana ..	11·4	9·7	0·5	22·8	19·4
Hongkong ..	23·6	36·6	2·6	9·1	14·1
Jamaica	25·4	22·9	1·6	15·9	14·3
Kenya	13·2	31·8	6·2	2·1	5·1
Malaya	44·0	38·8	6·3	7·0	6·2
Nigeria	85·4	59·6	33·5	2·5	1·8
Rhodesia Nyasaland ..	83·2	60·5	7·5	11·1	8·1
Singapore ..	26·4	40·0	1·5	17·6	26·7
Tanganyika ..	9·9	11·3	8·6	1·2	1·3
Uganda	6·7	7·2	5·7	1·2	1·3
F. United States ..	482·9	258·6	171·2	2·8	1·5

(1) 1957 or latest available.
(2) Excluding population of United Kingdom.

inventions originated in Britain and with which the name of J. L. Baird, a fellow countryman of mine, is so closely associated. There is electronics, with all its diverse applications, including electronic computers in which several British companies are making outstanding contributions, a subject in which our distinguished President is himself very much interested and to which he also has made very large contributions. There is the aircraft industry, with the Viscount, the Comet, the Britannia, the Canberra—to mention only a few of our famous aircraft—pointing the way and the Rolls-Royce engine powering both British and foreign aeroplanes. There is the motor car industry, creating new records every year by its exports. There is shipbuilding, with "British-built" still the hall-mark of soundness and quality. There are machine tools, engineering products of all kinds, and chemicals, in many sections of which industries great advances have been made. And there are the consumer goods industries, in which the fiercest competition prevails but which has not prevented us from being still the world's largest exporter of textile manufactures.

increased volume of production

This is a very brief and sketchy outline of the situation as it is today, but it is far from depressing. It has produced a volume of production about 60% greater than in 1938 and exports in volume about 100% more than in 1938. During periods of inflation it is not much use talking about values. We can only compare these things in the volume in which we were making them before the War and in the volume in which we are producing and making them today. There are other countries which can show a larger increase percentagewise. We are frequently told of the tremendous advances that have been made by some of the other countries, such as Germany, but one must measure growth against the background of stature. On that comparison we have much to encourage us but nothing to induce or excuse complacency. Table I on the left shows the amounts of our imports and exports in 1957 and their distribution country by country. I should like to pay a tribute to the gentleman from whose Paper, published in *The Times*, I took this Table, Mr. Nicholas Stacey, of The General Electric Company, who is in the audience tonight.

What I have said to you is by way of introduction to the subject of my Paper, which is the European Common Market, the Free Trade Area and the Production Engineer.

The Second World War has done one thing which is enduring, I believe, and which can be of tremendous value to the human race. It has exposed the folly and dangers of nationalism, and the developments since the War have demonstrated and underlined the essential interdependence of progressive and truly civilised peoples. Even the greatest advocates of isolationism in all countries have come to see that no single country is strong enough to stand alone, either militarily or economically. That has a lesson when one begins to think in political terms.

This does not mean, of course, and it is very important to recognise it, that nationhood is not a

worthy ideal. There are a great many countries in the world today who are striving to achieve nationhood. There are a great many peoples in the world whose greatest ambition is to become independent nations, and it is a proper aim for new and developing countries with peoples only starting to find themselves—but it does mean that nationhood, once achieved, should be prepared to take on membership of a wider community of nations and be ready in so doing to transfer to that wider community a part of its national sovereignty.

It is this idea, the transfer of sovereignty, which has underlain the initiation and development of the various European Communities and it is with these Communities and their consequences for Britain and British industry that we are concerned this evening.

This transfer of sovereignty is obviously something that gives people a great deal to think about, particularly in a country like this.

significant developments

It would be a mistake to underrate the significance, as well as the importance, of these developments in Europe. There has been nothing like them before in history. They are the outcome of practical, sensible thinking by practical, sensible, and politically-conscious men determined, indeed dedicated, to build up true and far-reaching and long-term, co-operation between peoples with similar problems and similar outlooks and possessing or working steadily towards, standards of living and of social conduct that are worth defending and which are capable of continuous and progressive improvement.

By " co-operation " these men did not mean inter-governmental arrangements and agreements which might work for a time, but were full of escape clauses and time limits. They meant integration, a transference of national sovereignty in vital sectors of the national economies, the creation of supra-national, or, if you like it better, federal, institutions, so that step by step, by conscious and predetermined stages, the interests and important elements in the lives of the peoples concerned should become so interwoven, and their aims and objectives so identical and identified, that there could be no question, as there would be no object, of their interests clashing or of them coming into violent conflict with one another. The natural development would be rather to extend the system into political and military fields.

You may think that what I have been describing sounds fine but is a bit airy-fairy and idealistic. That is not so. I am speaking of something that exists already and which has entered upon new and very significant phases during the past twelve months.

I would not have chosen this subject — one which also was suggested to me by your office-bearers — for my Paper tonight had it not been that this is something that is real. It is existing. It is something to which we in this country must pay a great deal of attention.

It began in June 1950 with the Schuman Plan when M. Robert Schuman, the Foreign Minister of France, launched upon the world his dramatic proposal that the coal and steel production of France and Germany should be put under a common authority and that other nations should be allowed to join in. There followed a conference—which Britain was invited to join but decided for sound and reasonable reasons not to do so on the lines proposed — in which four other European countries participated and, in April, 1951, a Treaty, having a duration of fifty years, was signed by the accredited Ministers of France, Federal Germany, Italy, Belgium, Holland and Luxembourg, representing the governments of six nations which had between them at that time a population of close on 160 millions—approximately as great a population as that of the United States of America and not so far short of that of the Soviet Union.

By 25th July, 1952, the six countries and their parliaments had by their normal constitutional procedures ratified the Treaty and it came into force. There was thus established—and it opened its headquarters in Luxembourg in August 1952—the European Coal and Steel Community, a body which had transferred to it, under the terms of the Treaty, powers of government in the spheres of production, development and distribution of these basic and essential products, powers which until then had been exercised by each of the member governments separately and independently.

This was a very big thing, because it meant that as from that date the Germans could not give any orders in these particular spheres to their own coal industry, nor the French, nor the other countries I have named. The only body which could issue decisions having the force of law in respect of these particular aspects of these industries was the High Authority of the European Coal and Steel Community.

The Treaty charged the Community with the duty of creating a common market for coal and steel in place of the more restricted national markets hitherto existing.

what is a common market ?

We might pause for a moment to consider what a common market is. In brief terms it implies a market in which there are no customs duties, quotas, subsidies, currency restrictions, transport or other discriminations affecting the free flow of trade between the member countries together with a reasonable mobility of labour, especially skilled labour. I say reasonable mobility of labour because obviously they do not anticipate that people would move as freely as they might wish to between the countries, and which might create very difficult national problems. It was designed specially for skilled labour as between member States and as was, also, the equalisation of those elements, social and otherwise, which enter into and influence the cost of production.

This is one of the big arguments and difficulties in bringing the countries together into a Common Market, this fact that the social burdens which affect the cost of production are frequently different in different countries. In some cases they are borne by the industry, in some by the body of national tax payers, and the way in which they have an impact

on the cost of production is therefore different in different countries.

In carrying out its task the Community had to do a number of things which the production engineer will recognise as his own type of function at its highest level and in its widest context. These things can roughly be described as:

(*a*) stimulating smoother and vigorous economic expansion;

(*b*) promoting rational distribution of production;

(*c*) achieving a high level of productivity;

(*d*) increasing by expansion of output the total employment available;

(*e*) giving greater security of employment;

(*f*) raising living and working standards.

All this was to be accomplished under rules which maintained and encouraged competition and was to be regarded as a first step in the construction of a United States of Europe.

It is not my purpose this evening to dwell in any kind of detail on the European Coal and Steel Community. I want merely to use it as an illustration and as a living example of what is now developing in other spheres.

This first of the Communities was furnished under the Treaty with a number of institutions. There are people who dislike institutions and fear that they import rigidity and obstruct flexibility. There are many who regard institutions as a consequence, as something that, so to speak, develops after. There are others who regard institutions as an essential foundation or starting point—something that comes before.

It is to this third category that M. Schuman and that great protagonist and moulder of integration, M. Jean Monnet and—if I may include myself with such distinguished company—I myself belong. Without institutions, which really means without organisation or tools or instruments, you cannot plan your operation. Therefore in the Treaty creating the first Community there were established:

(*a*) a High Authority, which I would liken to a government or administration;

(*b*) a Court of Justice to ensure that the rule of law should prevail in the application of the Treaty;

(*c*) a Common Assembly or Parliament to debate and discuss proposals and decisions and with power to dismiss the High Authority; and

(*d*) a Council of Ministers to ensure that national considerations were not overlooked and to take decisions in matters affecting the Community but not transferred under the Treaty to its sole jurisdiction; and, finally,

(*e*) a Consultative Committee, not really one of the institutions having power but with advisory functions, representative of consumer, producer, distributor and operatives, to give advice to the High Authority based upon wide and special experience.

The reason I have told you so much about the Coal and Steel Community is that this is the pattern which has been set and developed for this new form of co-operation. It is based upon institutions designed and competent to direct and guide all aspects of policy and operation. And it is this pattern which has been followed in the two companion communities which have now been created:

(*a*) The European Atomic Energy Community (known as Euratom), and

(*b*) the most important of all, the European Economic Community, more familiarly known as the European Common Market.

There are some differences in the Treaties constituting these two new Communities when comparing them with the Coal and Steel Community, but I would advise you not to pay too much attention to them, because although they are slightly different in their construction from the Coal and Steel Community, the differences are not, in my view, so very significant since I believe that they will develop along similar lines. Those who have been working in Europe have noted that when these countries get together in these communities, they have a habit of beginning to understand one another better and they do reach agreements where people would not expect them to do so. Their High Authorities are termed Commissions, not High Authorities, and their powers are for the time being somewhat more circumscribed. They use, however, the other main institutions that serve the Coal and Steel Community.

This shows the connection between these Communities. When they set up the two new ones, they did not set up new institutions for some of the other purposes other than the duties of the Commission or High Authority itself. They used the existing Court of Justice which became also the Court of Justice for themselves. They used the Common Assembly, enlarged in numbers from 78 to 142, and the Council of Ministers and their Consultative Committees are still there but are slightly different, being moulded to their different tasks. For instance, different Ministers come to meetings of the Council of Ministers. Different types of advice are required. Therefore, the consultative committees represent somewhat different functions. An excellent chart of the Institutions of the three Communities, taken from a very useful booklet on the Community of the Six, recently published by Mr. David Webster, is shown in Table II, overleaf.

It is to the European Economic Community which production engineers in the United Kingdom and British business and industry in general must pay close and particular attention. The aim of this Community is to abolish by stages extending over the relatively short period of twelve to fiften years, customs duties and other restrictions and discriminations affecting trade between the six member countries and to harmonise their tariffs against third countries, that is to say, their import tariffs on goods coming into the Common Market from outside. All of this, as in the case of the Coal and Steel Community, is to be

accomplished without preventing, restraining or distorting competition. This is one of the key principles of these Communities: that they should encourage competition as between different producers. Their rules and regulations are directed towards that end and not towards the restriction of competition. It is quite an important element, because it has a big bearing on the efficiency which they are likely to have. All of us derive great benefit from the existence of a high degree of competition. We may not always like the competition, but it is good for us. They recognise that and they have made provision for it.

It is to be accompanied by measures permitting the mobility of labour, the mobility of capital, equality of pay and the banning of the ordinary types of subsidies. There is to be a common policy for agriculture, which does not mean that agriculture is going to be treated in exactly the same way as manufactured products, because that would not be possible within a reasonable period of time. There is going to be a good deal of working together in respect of agriculture. There is to be a common policy for the co-ordination of social policies including those relating to conditions of work, social security, accident and health insurance and trade union rights. There is to be a European Investment Bank, with a capital to begin with of the equivalent of a thousand million dollars to assist development and to help in modernisation and conversion. There is to be an association with the Common Market of the overseas territories of the member countries, whose development will be fostered and assisted by them all, backed by a very large special development fund exceeding at the outset five hundred million dollars.

You notice the term "dollars" is used, but they will not be provided with American dollars but with equivalent currencies. Dollars are used as a measure, very largely because of the dollar content of the Marshall plan.

facing reality

Let me give you the figures and statistics in broad terms which we must have before us when studying the Common Market of the Six. I do not intend to enter into detail in this Paper in respect of particular industries or groups of products. But I do advise you who are engaged in a diversity of occupations to examine the situation as it relates to the industry in which you are employed, and its prospects of growth or contraction and how growth can be stimulated and contraction be prevented. There is no use shutting our eyes to the reality of the challenge or indulging in illusory expectations.

I mentioned earlier that the population of the Six Community countries was at the outset of the Schuman Plan about 160 million. It is estimated that by 1970 it will have risen to 175 million. Their gross national product in 1955 was estimated at £45 thousand millions and projected into 1970 may be around £70 thousand millions. The exports of the Six in 1956 exceeded £7 thousand millions which figures includes trade between member countries which will, under the Common Market, become internal trade. When you compare with these figures the United Kingdom's

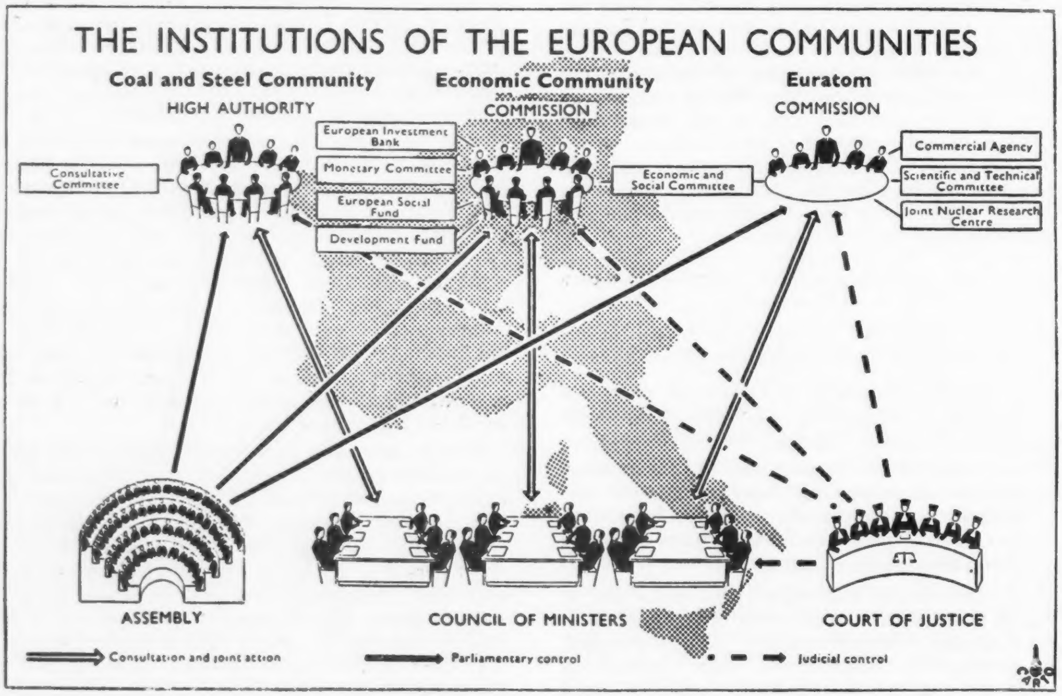


TABLE II

gross national product in 1956 of about £17 thousand millions and in the same year our exports (excluding re-exports) of well over £3 thousand millions, of which over £500 millions were to the Common Market countries, you get a measure of the dimensions of the Common Market operation at the present time and can make an estimate of what the comparison will be in 1970.

You can see what this development means for us in Great Britain and why it is so important that we should not be excluded from the Common Market but associated with it, along with other free European countries, having similar interests, by means of a Free Trade Area which will follow a tariff reduction policy the same as that operating in the Common Market on industrial products. It is not contemplated that it will be so in respect of agricultural products.

the crucial stage

Our Government is now at the crucial stage in the negotiations. May I say at this point that if there is anything that is bi-partisan policy in this country it might be said to be this question of our association with Europe, because I do not think either of the big political parties was ever anxious to enter the Common Market or the Coal and Steel Community. They both took much the same line in respect of this matter. Therefore, what I am discussing tonight has no political bias in it because the attitude of the two parties is very much the same. It is obvious that merely to co-operate on tariff reductions on industrial products betwen the Six and the other member countries of the Organisation for European Economic Co-operation will not be enough. Many other difficult and delicate matters will require to be agreed and included in any Treaty associating the other free countries of Europe with the Six. These problems must be resolved with all possible speed if we are not to face a period of dangerous uncertainty during which decisions of long-term significance may be taken by manufacturers and governments in all the countries concerned, and in some others of great political and economic importance, with regard both to the diversion of trade and to the location of new industrial investment. I refuse to believe that a solution will not be found.

That Britain is part of Europe, bound with it by ties of common peril and common effort and common sacrifice, the leader in its economic reconstruction after the Second World War, made possible by the Marshall Plan and guided by the O.E.E.C., the creation of which was due to the British Government at that time and in particular to Mr. Ernest Bevin, which has served Europe so well, is beyond all question of doubt or argument. That our fate will continue to be linked with Europe is geographically, historically, and by the instinctive processes of thought and hope, as certain as the flow and ebb of the tides. That Britain is also the centre of a great Commonwealth of free and independent nations attached to her by bonds that are intangible and interests that are natural and real, an association of peoples very different to that of the overseas territories of the Six, is another fact that cannot be, and I am glad to say by our European friends is not, disputed.

There will always be two opinions as to whether or not we in Britain would have been better advised to join the Communities as full members, accepting the necessity of surrendering a part of our sovereignty in certain spheres, and moulding the Treaties to take account of the Commonwealth obligations to which I have referred and giving the Commonwealth also and eventually, access to a vast and developing market.

But it is no use speculating on the " might have beens ", nor would this be a suitable platform on which to argue the toss.

We have made a Treaty of Association with the Coal and Steel Community and we must hope that in its different form we shall successfully create a Free Trade Area associated with the Common Market.

If we do, there is a new and immediate challenge to British industry and to the production engineer. We should be progressing swiftly towards free trade in the products of industry, a free trade which would not only allow us the entry into Continental markets on an equality with their own producers, but which would give the Continental manufacturers the same facilities in our domestic market which we enjoy ourselves. If we do not succeed in creating a Free Trade Area the challenge will be all the greater and of a less agreeable character. But one way or the other we must hold our place in the world.

At the outset of my Paper I referred to our forefathers' confidence in themselves, in their skill, their craftsmanship, their efficiency. We shall have to recapture that spirit of confidence in full. We shall have to make sure that our methods of production match or excel those of our most capable competitor, that our rate of productivity continues to advance, and that our adoption of aids to increased output is not restricted either by the fears of trade unions or the reluctance of management.

an appropriate task

Here is where the production engineer finds a task appropriate to his profession, suited to his training and vital to his country. It is to study continuously every new method of production being tried out or used in other industrial countries as well as in our own, and to apply the best of them in his own factory or workshop or whatever it may be.

The Britain in Europe Committee set up some little time ago, with the support of a number of industrial firms in this country, studied these questions and commissioned the Economic Intelligence Unit to produce a study of the effects on British manufacturing industry of a Free Trade Area and a Common Market. The book has been published. It is called *Britain and Europe*, and it has been a best seller. It has already sold about 15,000 copies, and it is very well worth reading. In this book the situation and prospects of each of our main groups of industry are placed under the microscope and analysed.

It is not possible in this Paper to examine the probable consequences for each British industry and the book, in any case, is available to all who wish to read

it. Its conclusions vary from industry to industry and are predicated on a reasonable level of capital investment without which inventiveness, technology, skill and effort will be handicapped.

But, by and large, over the wide fields of engineering, which embraces so large a part of British industry, in chemicals and in some, but by no means all, the consumer goods industries, we have nothing to fear from equal competition and much to gain provided, but only provided, that we go out for the business. By that I mean keep our methods modern and our production costs low, familiarise ourselves with the markets we must break into, sustain the campaigns on which we embark, study the habits, the practices and the design requirements of each customer country, and remember always that in a competitive struggle, matching goods against goods, values against values, and wits against wits, in the long run it will be the best that will win.

REPORT AND DISCUSSION

THE 1958 Sir Alfred Herbert Paper was presented by Sir Cecil Weir, K.C.M.G., K.B.E., M.C., D.L., Past President, to The Institution of Production Engineers, at the Royal Institution, Albemarle Street, London, W.1, on Thursday, 11th December, 1958, at 6.30 p.m. The President, Lord Halsbury, occupied the Chair.

The **Chairman,** in opening the meeting, said:

We are met here this evening to listen to the Sir Alfred Herbert Paper, one of the Named Papers of the Institution. I am sure it would be your wish that before proceeding to our business I, as your President, should thank the officers and servants of the Royal Institution very sincerely for the facilities that have been accorded to us for the purpose of holding this meeting, and for their time and trouble in preparing the lecture hall and laying on the canteen arrangements for us.

This is the third Sir Alfred Herbert Paper which has been held in the Royal Institution, and I hope the friendly relations between the two bodies are as much a source of gratification to them as they are to us.

The list of those who have presented The Sir Alfred Herbert Paper previously is getting rather long, and so I am not going to read the names beyond noting with pleasure that we have two of Sir Cecil Weir's predecessors with us this evening — Sir Walter Puckey, a Past President, and Dr. H. Barrell, of the National Physical Laboratory, who read us a very interesting Paper last year called "The Bases of Measurement".

It is our custom to mark our appreciation of those who give us these Papers by presenting to them on some suitable occasion a small present, suitably inscribed. It so happens that no suitable occasion has presented itself since this time last year to present Dr. Barrell with the little gift of silver which you see there and which we have for him. But since there is no time like the present, I am now going to ask if he would be kind enough to come forward and allow me to present it to him on your behalf.

Dr. H. Barrell, Superintendent of the Metrology Division, National Physical Laboratory, author of The 1957 Sir Alfred Herbert Paper, was presented with a silver rose bowl.

The photograph below shows Dr. Barrell (left) receiving the award from the President.

The **Chairman:** It is now my pleasant duty to introduce to you Sir Cecil Weir, who is to be our lecturer this evening and who will present to us his Paper on " The European Common Market, the Free Trade Area, and the Production Engineer ".

Sir Cecil, who is a Past President of the Institution, succeeded my friend and former colleague, Lord Mills, as Head of the Economic Section of the Control Commission in Germany. He was also former Head of the United Kingdom Delegation to the High Authority of the European Coal and Steel Community.

Apart from his very distinguished career, Sir Cecil is a man who is much loved and respected by those who know him. As a Past President of this Institution he is held in honour and respect by all of us, and although he has no longer to exercise any functions—because a Past President is a voteless man in the counsels of the Institution — he is always there with help and encouragement and wise advice whenever the officers of the Institution have wished to seek it.

Having introduced Sir Cecil Weir, I am not going to take up any further time on these comments save to draw your attention to the fact that this is the seventh Sir Alfred Herbert Paper.

I, therefore, call upon Sir Cecil Weir to read us his Paper.

Sir Cecil Weir then presented the Paper which appears on pages 53 - 60.

The **Chairman** said that it was not his function to offer the official thanks of the members of the Institution for the Paper. That would be done at the end of the discussion. But he might remark that when Sir Alfred Herbert gave his name to the Paper, he said that he would very much like the lectures to reach beyond the narrow aspects of the metalworking industries or the machine tool industry. Sir Cecil Weir's Paper fully complied with the wide terms of reference Sir Alfred had contemplated.

He called upon Mr. R. H. S. Turner, Vice-Chairman of the Institution's Council, to open the discussion.

Mr. R. H. S. Turner (*Vice-Chairman of the Council of the Institution*) said that Sir Cecil's very lucid description of the structure and functions of the European Economic Community, as well as the factors that had led to its formation, deserved the closest attention not only of production engineers but of everyone engaged in industry generally.

It must be realised — and Sir Cecil had made this abundantly clear — that there had been established within 20 miles of these shores an economic power greater than the U.S.S.R. and second only to the United States of America. That was something most people failed to appreciate in the ordinary way. Behind it there was a tremendous driving force. More than economic, it emanated from the certainty that Europe could not survive without political integration.

Mr. Turner supposed it was fair to say that today there were many reasons why this country should not be a member of the Community, but nevertheless the creation of such a unit must inevitably have major repercussions on our own economy. It meant that we must expect to see changes in our respective industries, in our wealth, and even perhaps in our own personal means of livelihood.

This, then, primarily was the challenge of which Sir Cecil had spoken. This part of his lecture was its most important aspect and he would like to enlarge on it for a few moments, if he might, in a fairly simple manner.

The form of the challenge would not be completely clear until it was known whether or not a Free Trade Area or an equivalent would emerge. He could do no more at this stage than endorse Sir Cecil's statement in refusing to believe that a solution to the present situation would not be found. It might be regarded as an *impasse* at the moment, but he felt this was purely temporary.

The industrial and economic strength of this country, coupled with geographical ties, made any alternative completely illogical, but where did this lead ? Within a Free Trade Area, as Sir Cecil had pointed out, this country's goods would be free to circulate in European markets without the encumbrances of import duties and so on, and European products would be for sale here under similarly advantageous conditions. It must be remembered that even with import duties some European products could compete successfully against British equivalents. Two familiar examples were Volkswagen cars and Italian shoes, both competing successfully despite import duties. The removal of customs barriers against them and against other items would intensify competition. British manufacturers would have to counter that by correct pricing and by improvements in quality and styling.

The entry of British goods into Europe on a larger scale might equally appeal — or not appeal — to Europeans in the same way. The Europeans' reaction would undoubtedly be the same as ours. Their industries might be expected to improve the excellence of their goods and to reduce prices by adopting more efficient manufacturing methods. Competition, therefore, must inevitably be more acute both in this country and in Europe.

More was needed than just waving a magic wand to take advantage of the opportunities offered in order to maintain our position, and we must not only know what was wanted and what should be its styling and quality and its price, but also be able to make sure that it would sell.

These were problems for the production engineer, working in collaboration with design and commercial staff. And here it should be remembered that the future of industry would depend on a very much closer collaboration between the various sides of industry, particularly with regard to the connection between the production engineer and design and commercial staff.

Other problems were likely to follow. For example, this country might be forced to adopt European instead of national standards, which would clearly involve a wider use of the metric system. That was a thought worth bearing in mind. These questions, all of them, might cause one to ponder, but the potential nevertheless was great. The figures in the Table in the Paper showed this quite clearly.

A further factor of signficance was the expected growth of the installed capacity of electrical generating machinery, which appealed particularly to Mr. Turner. This was estimated to increase in O.E.E.C. countries from 137,000 MW in 1960 to 322,000 MW in 1975. It was interesting to note that the corresponding figures in the United Kingdom were 33,000 MW and 70,000 MW respectively.

The possibilities for the British electrical manufacturing industry with Germany as the only competing country having an electrical industry of comparable size were, to say the least, substantial.

Although there was much to be gained by a Free Trade Area, the impact would not be the same on all the industries of the country, as Sir Cecil had pointed out. Indeed, the F.B.I. had gone out of their way to point out that whatever results were achieved, it would remain a balance compounded of advantages and disadvantages. It even went so far as to make recommendations to be adopted by industries which might be particularly hard hit. Similarly, the Trades Unions, while supporting Government policy in this respect, were conscious that their problems would be accentuated, because of dissimilar working conditions in different parts of Europe. That would be an increasingly important factor.

By no means the least problem to be considered if, in fact, this country was associated with a Free Trade Area was its effect on the Commonwealth and other sterling area countries. The advantages to be gained must not be allowed to befog the fact that about 47% of this country's exports went to the Commonwealth, whilst the Common Market countries took only 14%. Should the negotiations for the Free Trade Area fail, the figure of 14%, instead of increasing, might, of course, possibly dwindle to a negligible figure.

A difficult problem would then arise in which it would be necessary to find new customers, either in established or in fresh markets. In this context, consideration might be given to the extent to which Canada's growing population and expanding economy could provide an outlet for British industry. The Canadian Government were seeking trade with this country, and it would be an error of the first order not to pay heed. Indeed, in some quarters it had been suggested that there was more to be gained by associating with Canada than with the European Common Market. However, this was only one possibility. There were other markets into which United Kingdom products could be introduced.

Again, none of this would necessarily be easy to do. There might be strong competition, even in established markets, from members of the Common Market. Economic followed by political integration would surely increase their ability to compete with this country throughout the world, possibly with methods similar to those adopted by the U.S.A.

This, then, as he saw it, was the picture. Whatever might be the outcome of the Free Trade Area negotiations new markets must be found, and the quality, price and styling of the products of this country must be such that they were acceptable to the purchasers in those markets. All levels in British industry would be involved and the part played by the production engineer would not by any means be the smallest.

Sir Cecil Weir had said that we must regain our confidence to meet these new conditions. As he had said, history showed that there was no reason why this should not come about. The first step, therefore, was to understand what was happening and to this end he would suggest that Sir Cecil had helped us very considerably on our way.

Sir Thomas Hutton (*formerly Director of The British Productivity Council*) said that in such distinguished company it would be inappropriate for him to talk about the production engineering side of the problem. Therefore, he would like, if he was not out of order, just to summarise the present position as regards the negotiations, as a background to the more technical aspects of the problem.

To go by the headings in the newspapers, one would think that at the present moment there was a dispute between Great Britain and France and that was all that mattered. It should be realised that this was not really the case. The position was one of very difficult negotiations between the six Common Market countries and the 11 other European countries; and some of these 11 would be much harder hit than this country if there were no Free Trade Area. For that reason, it was a great pity that more prominence had not been given to their views.

The situation was that all the European countries, except France, were satisfied that it would be in their interests to have a Free Trade Area. Only a day or two ago the *Bundestag* passed a unanimous resolution urging the West German Government firmly to use its influence to bring about European economic cooperation in the form of a Free Trade Area.

One reason for the stalemate was that the Common Market countries were unwilling to put such pressure on France at the present time as might jeopardise the Common Market itself; and this was very understandable. Those who had studied France's economic position must inevitably have a great deal of sympathy with her, although it was difficult to sympathise with the way in which she had conducted the negotiations.

At the present time there were two alternatives, which would not, however, reach their full development for 12 to 15 years.

The first alternative was a Free Trade Area with no tariffs or quotas covering nearly the whole of European trade, except in those sectors of trade where there was a danger of diversion of trade owing to the external tariffs of the Common Market being higher than those of the European countries outside the Common Market. In that case, certificates of

origin might be necessary in order to qualify for free trade treatment. Otherwise, our exports of manufactured goods would have free access to all the markets of Europe and they would have free access to ours. Of course, that would have an adverse effect on some industries in this country and a favourable one on others. But he would suggest that the pattern would not be industry by industry. The efficient firms would survive and expand, and the high-cost ones would go under. But in some industries it would be more difficult to survive than in others.

The second alternative was a Common Market only, in which exports from this country to the Common Market would have to face tariffs and perhaps quotas. For example, Germany would be able to export to France or Italy without any tariffs or obstacles of any kind, while our exports would have to pay customs duties.

It was clear that whatever the final outcome, there was a serious challenge to British industry and possibly an opportunity as well. It was urgently necessary to extend the principles and techniques of production engineering over the whole field of British industry. There were many organisations working in that field, and the British Productivity Council, with which he had been associated, had been trying to reach those sections of employers, work people, trades unions, who did not normally have contacts with a professional institution.

He would like to say here how much the British Productivity Council owed during his term of office to the support received from The Institution of Production Engineers in trying to carry out that work.

Mr. A. A. Jacobsen (*Works Manager, Motor Accessories Division, S. Smith & Sons Ltd.* (*Witney*)) said he was speaking mainly because the Oxford Section of The Institution of Production Engineers had organised a series of specialised lectures giving detailed views on the European Common Market.

He wanted to plunge right back to Lord Disraeli and what he had said in 1838, 120 years ago :-

> "The Continent will not suffer England to be the workshop of the world."

Those were his words, although they might have been quoted elsewhere and he knew what he was talking about. He was a man of great vision and looked right forward 120 years to the present time. For the first time the Continent was waking up and doing something about it; and frankly the prospect was alarming.

The creation of a market of 164 million persons — and a market, he understood, as a production engineer, meant a place where one sold — would make available to production engineers a mass market of tremendous strength and tremendous power. He believed the rise of American prosperity was due to the presence of a powerful large market contained within certain frontiers. He did not propose to go into questions of mass production or the production of large quantities. When markets had been fairly established and indicated the type of production required, it was possible to concentrate on operations and get down to producing cheaply.

Speaking as a production engineer he was confronted with a home market and with salesmen who were selling to 50,000,000 people. Exports followed, but his friend over in Germany, with his Teutonic efficiency, would take advantage of a market of 164 million people before he began to export.

The lesson that should be learned from the European Coal and Steel Community — and the point that should be made — was that on the Continent they had decided to proceed from there. Whatever the difficulties and however badly things might have been managed, they had decided to go ahead as hard as they possibly could after laying the pilot scheme.

But the real threat lay not in the statistics quoted in any of the papers, as he saw it, and the fact that this country might lose £14 million of trade, or whatever it might be per annum, was only secondary. The matter was a long-term one of 50 years ahead.

The increased efficiency that would result from this market from the production engineers combining, from people getting together and facing their problems, would be such that this country would be threatened in world markets. This country was not taking any comparable steps, whatever might be said, to create conditions in which efficiency would build up in such a basic manner. Therein lay the real threat — that the European Community, with this Common Market, might become such a powerful export force that it might well prevent this country from maintaining and raising its standard and individuals from maintaining their own standard of living.

Councillor W. J. Evans (*Managing Director, J. Evans & Son* (*Portsmouth*) *Ltd.*) remarked that the speaker had said the purpose of the Paper was to give a wide appreciation of the problems of today. Were not the political implications far more serious than competition in industry ? Free movement of capital and labour must sooner or later surely lead to a political entity. Then this country would be faced with a situation it had striven to avoid through many wars over the past two or three centuries.

Sir Cecil Weir, in reply, said it was difficult to say what was political and what was economic. They become so mixed up together. He thought he had made clear in what he had said that having made these arrangements in the economic field, it was only natural that the countries should develop them in other fields as well. He did not know that the United Kingdom had striven to prevent the setting up of a federation in Europe. He did not believe that that was the aim today. He thought the aim of this country was to bring people together. He thought both the Government and the Opposition in this country were in favour of the movement towards integration in these European countries.

The question bothering this country was not that they were getting closer together, but how it could be associated with them, bearing in mind its somewhat

The photograph, taken at the reception preceding the Paper, shows Lord Halsbury with four Past Presidents of the Institution. From the left are: Mr. E. W. Hancock, O.B.E., Hon.M.I.Prod.E.; Sir Cecil Weir, K.C.M.G., K.B.E.; Lord Halsbury; Sir Walter Puckey; Major-General K. C. Appleyard, C.B.E.; and Mr. G. Ronald Pryor, Vice-President.

different problems as a country having a great Commonwealth associated with it.

The political implications were probably the most important.

The whole discussion up to the present had been extremely interesting. Perhaps it might help further discussion if he were to deal with one or two of the points made by other speakers and not leave too much to say at the end.

Those who had spoken had made most interesting interventions and he agreed wholeheartedly with what Mr. Turner had said as the opening speaker.

Mr. Turner did suggest that if this country could not develop in Europe, it might develop further in Canada. An attempt was being made to do this as much as possible. It was true that the atmosphere in Canada was favourable. But all these European countries, if their manufacturers were efficient, would also get trade from Canada. To retain its position as the greatest exporting country in the world *per capita* this country would have to ensure that it was more efficient than anybody else. He did not think there was any other way of dealing with this matter. The authors of the book to which he had referred recognised — and in this he agreed with Sir Thomas also — that some industries would suffer as a result of these countries getting together in Europe, as Sir Thomas had realistically said. But there were a number of firms in those industries which would not suffer because they were extremely efficient and had faced up to the situation before and had been successful.

But after all there was no object in being afraid, because if this country was afraid of equal competition it would advance nowhere. It would only succeed if it had confidence in itself and could ensure that productivity and production costs were favourable — that production costs were lower and productivity higher than in other parts of the world.

Sir Thomas had referred to France, and to the problems of external tariffs and certificates of origin which would be necessary if this country did not harmonise its external tariffs with the external tariffs of the six countries. This was one of the big problems facing Mr. Maudling at present. If goods from outside Europe came in to the six countries from the countries associated with them in a Free Trade Area, having been subjected to different tariffs from those which the six were adopting themselves, the question of certificates of origin would arise in a big way. This could be a terrible nuisance in respect of documentation and so on. The suggestion was that the external tariffs of the Free Trade Area countries should be harmonised with those of the six. This was a problem which he did not know how we were to deal with, but it was clearly a very important one.

Mr. Jacobsen had referred to the advantages of a mass market of 164 million people. He had suggested that that was the basis and secret of the prosperity of the United States. He was absolutely right and what he himself was hoping was that arrangements with the Common Market would make available a market of 250 million people. With other O.E.E.C. countries, who were not in the Common Market, added to a Free Trade Area, there would be a mass market of 250 million people, bigger even than that of the United States of America in the next 10 or 15 years.

a great opportunity

That would offer a great opportunity to production engineers. It would offer a great opportunity to manufacturers. But it would also be a great challenge to them, because — as he had pointed out — other countries would have the same access to this country's market as it would have itself.

The only answer was to be more efficient than the other chap unless this country was to get less of the business and other countries more. However, he had every confidence that this country could be very efficient. He had every confidence that it was efficient now.

He thought some unnecessary bogies were being put up. He agreed that it was more difficult for some industries than for others. Sir Thomas had pointed out that what should be British action must not be judged by the effect on a single industry. The effect on British industry as a whole must be considered. It was his own contention that if an industry could not survive against competition, it would

diminish anyway and, indeed, it might be a healthy spur for it to be exposed to a certain amount of competition. There was no spur to efficiency that was greater. It was very unpleasant and disagreeable at times but there was no other way of ensuring survival than by being able to compete with the other man.

The political implications were extremely important and one thing led to another. That was, indeed, the aim and objective of those who started the thing. They had made no secret of their intention to create in Europe a United States of Europe which would be as prosperous and as powerful as the United States. Associated with the United States, as Europe would be and as this country would always continue to be if it were wise, we could create a partnership so powerful that no power in the world could destroy it.

Mr. B. H. Dyson (*London*) said that as Sir Cecil had pointed out production engineering had certainly come into its own and rightful place during the last 20 years, so much so that there were now production managers and directors, but it must be appreciated that one could not have authority without accepting responsibility. He wondered whether production managers and directors had taken enough responsibility in helping to bring about a final solution to this particular market problem. Were they not perhaps sitting back and saying the Government was dealing with this and they would wait and see what happened ?

In his frequent travels on the Continent, he had been assured by industrialists in many of these countries that the European Market was not simply a politician's dream. It came from industry, who had pushed their politicians in order to get the idea into operation. It was up to industry in this country to do the same thing.

What he was worried about was that British industry knew about the European Common Market two years ago and that it now came into operation in three weeks' time. Production engineers knew that if they got the plans, drawings and specifications for a new project and were told to get it into production in two years' time, and that advertising and publicity were going ahead, they would not stay very long in the business if, three weeks before the launching date of the new product, they said they had not got the tools.

He had recently talked to a number of Swiss and German industrialists in Berlin, and they had voiced the fear that European industry was being hemmed in by the Iron Curtain on the one side and a nylon drape on the other side. They did not like the idea of the world trade stool with only two legs, a red leg and a striped leg. They were pretty certain this country was not going to help the red leg, but they were not too certain about the stripes. World trade would be more stable as a stool with three legs and a strong blue-blooded leg in the form of a United European Market could be the solution. British industry had to remember that their very good production engineers had produced British bicycles that were the most efficient and at the lowest prices. But there was a little song on the other side of the Atlantic which ran :-

"Fee, fi, fo, fum,
I smell the goods of an Englishman,
If his quality's right and the price is low,
Put up the tariffs lest his imports grow."

European industrialists, therefore, suggested it might be very well for this country to come into the European Market.

Mr. Dyson believed production engineers had to accept the challenge of change and that for too long they had been satisfied to talk about floor to floor times of productivity. This was a job of selling in the European market and in that respect costs did not consist of floor to floor times, but of door to door times. The production engineer had to engineer production of the job from his material supplier's door to the European customer's door, which was a much wider and bigger aspect.

Fears had been mentioned about British industry being competitive; one fear he had was that in the past year in West Germany the R.E.F.A. organisation had trained 7,000 work study engineers. There were now 70,000 efficient trained work study engineers operating throughout the length and breadth of German industry. This was the challenge to worry about rather than cheap labour, because he did not think there was any such thing as cheap labour. One got what one paid for.

A member of the audience pointed out that up to date, or nearly up to date, the European Coal and Steel Community had been operating in what might be called a seller's market. There now seemed to be a turn in the tide, and they would be operating in a buyer's market. How did Sir Cecil think this would operate in the future ? In other words, would they go along quite so happily in the circumstances with which they might be faced at the moment ?

Sir Cecil Weir, in reply, said that this was a question that had often been asked during the first few years of the Coal and Steel Community. The market was not quite a seller's market, but generally speaking it was now much more so. One asked oneself whether or not it would hold together in the same way if conditions became more difficult. But the Treaty was designed to deal with just exactly this kind of situation. If there was a slump, or condition of glut, it was to be treated as an emergency, and under the terms of the Treaty the parties would then give production quotas to the different producers. They would fix minimum prices so as not to let good producers be driven out of business in a slump, and the situation would thus be cushioned in an endeavour to prevent a bad state of trade developing into a complete slump. This had not happened yet : the situation had not been as serious as that.

Provision had also been made in the event of a shortage, but as far as he could see they felt they could deal with situations of either kind, because nothing had been heard of a break-up in the Community so far. On the contrary, they seemed to have

become accustomed to working together — to have got the community idea and to be applying it.

One of the extraordinary things in this Treaty, as was probably known, was that for a period the German and Dutch coal producers were paying a certain amount of money to the Belgian coal producers in order that the Belgians should mechanise their mines and try to produce at a cheaper price. It was extraordinary for two countries inside a Common Market to put a levy on themselves in order to help not their own producers, but producers in the Common Market. So he had a feeling that the Coal and Steel Community was standing up very well.

There might be someone present who was associated with the Coal and Steel Community who could say exactly what was happening, but he had not heard of any rumpuses or ructions so far.

Mr. E. R. Lingeman (*Director, Britain in Europe*) said he thought the speaker who quoted so aptly from Disraeli took a very pessimistic view of the Common Market and its repercussions and influence on British industry and on the prosperity and standard of living of this country. First, he postulated that there would be no Free Trade Area, which was still a very open question. Secondly, there was the possibility that a Common Market without a Free Trade Area would not be altogether successful. He was one of those — and he believed Mr. Maudling was another — who believed that the Common Market would not operate without a Free Trade Area. This would be the case more specially if, as seemed almost inevitable, the rift in Europe lead to retaliation on the part of other members of O.E.E.C. who were not in the Common Market and had no wish to join it.

He believed that the difficulties which would arise naturally from this rift would lead to the development of a great deal of resentment against France within the Common Market for having put so many spokes in the wheel of the Free Trade Area, with the result that internal dissension would occur. He had heard a foreign economist state quite recently that in about four years, i.e., at the end of the first period, France would have adapted herself to the conditions imposed by the Treaty of Rome under the Common Market and that would be about the time when a closer form of European economic integration could take place. But this was a long time to expect the other members of O.E.E.C. to possess their souls in patience.

Mr. Turner had referred very aptly and justly to our need for new markets. That need would, of course, be very much accentuated if there were no Free Trade Area. The greatest opening for new markets was obviously in the development of the primary producing countries, a great number of them normally regarded as backward countries, although some of them were both primary and industrial producers and very highly developed under both headings. What they needed today in order to acquire greater prosperity — which would lead to wider purchasing capacity and greater and more varied consumption — was "know-how" and capital.

The question of greater capital investment overseas was the subject of continuous debate, often by people who forgot that the supply of capital was strictly limited, certainly so in this country. The return on capital investment in the backward countries was apt to be much smaller than investment in European industrial development. Without a Free Trade Area there would be a natural tendency for British industrialists, who had the means and the capacity to raise additional capital, to do as the Americans were doing — to invest in the Common Market in order to develop production behind the tariff wall, that in a short time would be built up around it.

Germany would presumably derive substantial advantage from her extremely buoyant financial position and her accumulation of foreign exchange reserves. This would allow her to place capital abroad on the most favourable terms offering in areas of her own choosing.

A subject of the greatest interest in this context was the history of our own capital investments abroad, with particular reference to various misfortunes which had accompanied capital investment by this country, for instance in Latin America. American capital was pouring in there, whereas British investors were still chary of exposing themselves to disasters which their predecessors had experienced in the past.

Positive steps would, Mr. Lingeman thought, have to be taken to keep pace within the resources of this country, with what was likely to be far more intensive capital investment in the primary producing countries by the United States in the first place, and Germany in the second.

Mr. H. G. Millington (*London*) said he would like to stress a point that had been raised already. Before the production engineer rose to meet the challenge of the Common Market it was essential for him to know what had to be made. It was no good expertly making something very cheaply if it was not wanted. Market research was most important and should be going on now. It was not usually the prerogative of the production engineer, but his voice should be raised in his own firm in order that this point should be recognised as paramount and preparations could be made for the future.

In reply to a question regarding the adoption of the metric system, and whether it would help the United Kingdom to meet the challenge, **Sir Cecil Weir** said he would not like to express any opinion on this very controversial subject. He had no doubt there were great enthusiasts for the metric system and there were a large number of people who were opposed to it. It was obvious that entrance into a Common Market would cause this country to consider very carefully the arguments in favour of the metric system and he agreed the point was important.

Another member of the audience asked whether all that had been heard about the hardworking characteristics of their Continental friends was true. Did the Continental workman work harder than the British workman ? He knew that offices in some of

the Continental countries opened at seven and closed at six.

Sir Cecil Weir, in reply, said he had never expressed strong views on this subject because it varied in different countries. He personally had very good experience with British workmen. He had had no bad experiences at all in his own Company, and this was true of a very large number of other people in the audience.

He always hesitated to express in public a view which he could not support from his own experience that other countries worked harder and better than the United Kingdom. Everyone knew the German worked hard. He loved to work for work's sake. It was a great characteristic and a great quality of the German people. But the British working man was still as capable as ever of doing a job. It was largely a question of good leadership and good management.

It was suggested by a visitor that it might be a good thing if the figures for exports and re-exports were broken down to give individual figures. The important thing seemed to be to export products with a high conversion factor. This country had depended in the past to a large extent on goods which had been imported and then directly exported at a fair profit. The fact remained that that could get out of proportion and lead into a misleading situation if it was not appreciated.

Sir Cecil Weir said that it was most important that export figures should be broken down, but figures were already available. The Board of Trade published trade statistics showing the amount of re-exports and exports of every major group of commodities and this publication could be obtained on application to H.M. Stationery Office. It was pretty well up-to-date, perhaps even more up-to-date than three months.

The **Chairman** said he might perhaps be permitted to make one observation before closing the discussion. He had never had anything to do with the Common Market or European Free Trade Area, but he had been very impressed with the quality of those who were connected with it, both in this country and on the Continent. He could only describe their spirit as a robust, adult recognition that things that were good for one were not always very nice to take. No one really liked competition but there was a recognition that it was good for one. No one liked anti-trust legislation, but it was good for one. They were like cold baths in the morning and nasty medicine.

There was a Birmingham business man who was so distinguished that he would forbear to give his name. When told about the Free Trade Area proposals for the first time, he was silent for a little while and then said : " We shall be outworked by the Germans, outpriced by the Italians and outsmarted by the French ". Then he paused and added : " Some of us any way! Maybe that won't do some of us any harm ".

The Chairman had listened with admiration to Sir Cecil's *exposé* of all these matters, and he would now call upon Mr. Stokes, Chairman of the Institution's Editorial Committee, to propose a vote of thanks for the Paper.

Mr. B. E. Stokes (*Chairman of the Editorial Committee of The Institution of Production Engineers*) said that after all that had been said and written on the subject in the last two years, it had been refreshing to be reminded in clear and straightforward terms just what it was all about. Thanks were certainly due first to Sir Cecil Weir for that. Furthermore, he had made clear the challenge and the opportunity of the situation, a point amply demonstrated during the discussion.

Sir Cecil had left it to each one individually to decide what action ought to be taken to meet the challenge. He had given a very clear lead as to what might be done in his excellent summary of what the authors of the Common Market meant by co-operation on page 56, paragraph 4. He said :

> " They meant integration, a transference of national sovereignty in vital sectors of the national economies, the creation of supra-national, or, if you like it better, federal, institutions, so that step by step, by conscious and predetermined stages, the interests and important elements in the lives of the peoples concerned should become so interwoven, and their aims and objectives so identical and identified, that there could be no question, as there would be no object, of their interests clashing or of them coming into violent conflict with one another."

Suitably rewritten, this might prove a very good general guide for action within industry. Come to think of it, it might prove a very good general guide for committee meetings of the Institution.

After such an absorbing and enjoyable evening, it was a pleasant duty, if it be a duty at all, to propose, on behalf of The Institution of Production Engineers, a most hearty vote of thanks for an admirable Paper and an excellent response to the discussion.

The vote of thanks was carried by acclamation.

Sir Cecil Weir thanked Mr. Stokes very much for his kind words and the way in which he had said them. He also thanked those present for being such a nice audience to speak to. He had enjoyed it very much. He had known that he would have a very intelligent audience and that the subject was one that a number of them would have considered already. The discussion had indeed been very useful.

He would like also, if he might be allowed to do so, to thank Lord Halsbury for being such a splendid Chairman. It was a great privilege for the Institution to have such a man at the present time, because he was one of those who did that very thing about which so much had been said — research into the future. This would have to be done if they were to hold their place in world trade.

The proceedings then terminated.

some recent developments in spiral bevel gears

by Frederic Rochat*

Summary

The manufacture in series of the SPIROMATIC bevel gear generator began in 1948. These generators have been supplied in appreciable numbers to various countries.

The Oerlikon gear cutting process derives from systems originated about forty years ago, such as continuous indexing, face-type milling cutters with inserted blades, and constant tooth depth. The gear tooth curves thus obtained are portions of extended epicycloids.

The processing operation from blank to gear is performed in one single cutting, divided into a first phase, during which the tooth spaces are grooved in the course of a plunge-cut motion, and a second, subsequent phase, during which the tooth profiles are generated through a rolling motion.

New standard cutters with a wide working range ensure remarkably short production times.

Owing to the mathematical simplicity of the process, to the ready and practical method for obtaining localised tooth bearing (crown), calculations are reduced to a minimum, and correct gears are produced from the start without any trials.

* Oerlikon Machine Tool Works Buehrle & Co., Zurich

THE two alternative methods of generating spiral bevel gears with rotating tools are:

1. Each tooth space is generated separately while the gear blank is held stationary, the gear blank being indexed after withdrawing the cutter from each tooth space (Gleason method).
2. All tooth spaces are progressively cut during uniform rotation of the gear blank (Fiat, Klingelnberg and Oerlikon methods).

The object of this Paper is to report on the latest developments of the Oerlikon system, i.e. of the Eloid gears, the tools, and the machine. This machine, the Spiromatic No. 2, already well introduced, was not built in series by the Oerlikon Machine Tool Works before 1948.

historical background

The first spiral bevel gears to be produced by continous indexing were obtained by planing, by the Monneret method (1900), a process which was later adopted under various forms by Gleason and by Brandenberger (in the case of Oerlikon, from 1926 to 1936). Considering that the cutting method by planing involves idle times of the same order of magnitude—sometimes even longer—than the productive times, it was logical to expect that processing methods using milling cutters would soon be adopted, as was done previously for spur gears. In this case, face-type cutters with inserted blades, as well as taper hobs, usually one-piece, can be used.

On 15th September, 1916, a patent was filed by Gleason for a spiral bevel gear cutting method without indexing mechanism, the tooth depth being proportional to the cone distance, as in the case of straight bevels.

On 8th March, 1917, a Swedish inventor, Wingqvist, filed a similar patent, but involving gears with the tooth depth constant over the facewidth. A detailed description of this system can be read in

Part Two of Schiebel's treatise, " Zahnräder ", published by Springer in Berlin.

The cutting method by taper hobs is described in the first patent filed by Trbojevich in USA on 22nd January, 1921, in various other patents by the same inventor, filed in the following year, and in a paper published in the European issues of " American Machinist ", October/November, 1923.

It will be noted that a fairly long time elapsed before the relatively early conception of processing methods with milling cutters and by continuous indexing found actual industrial application.

the Oerlikon system

Like other European designers of spiral bevel gear cutting machines, Oerlikon apply the continuous division principle, such as can be carried out on machines which do not embody intermittent indexing mechanism. It is worth remarking that, nowadays, for large series production of spur gears, the systems implying continuous division (Fellow type, and mainly by hobbing) are by far the most widely used.

The system adopted by the Oerlikon Machine Tool Works derives directly from Wingqvist's descriptions: continuous cutting by a face-type milling cutter with groups of inserted blades, and constant tooth depth over the facewidth. Constant tooth depth has the outstanding virtue of being the only condition permitting the generation of conjugate gears by means of straight edge cutting tools. Constant tooth depth alone permits the mathematically correct computation of the data of bevel gears generated by means of face-type milling cutters or hobs.

tooth curve generation

Fig. 1 illustrates the principle. The cutter rotates about C in the direction of the full arrow, the imaginary flat gear (of which the development of the gear generated is a determined portion) in opposite direction about M. When C and M are assumed stationary, these two rotations feature the dividing motion.

The cutter has a number z_w of identical blade groups (five in the case shown by the figure), one blade group engaging one tooth space and the following group the following space. Each group comprises an outside cutting blade (A) that shapes the concave tooth surfaces, and an inside cutting blade (I) that shapes the convex surfaces of the gear. The figure shows, lying in one plane, the tooth pitch curves of the imaginary flat gear, i.e. the pitch points of the cutter blades, the latter being evenly distributed on a common circle with centre C and radius r_w. Inside cutting blade I_1 of the first group is shown at the intersection P' of a convex tooth pitch curve with a circle with radius Rp. The moment at which the outside cutting blade A_1 of the same group meets the circle with radius Rp, the gear must have revolved by half the pitch, as blade A_1 belongs to the concave surface pitch line that must contact the job at point P''. Similarly, when the inside cutting blade I_2 of the following group meets the circle with radius Rp, the gear must have rotated by one pitch.

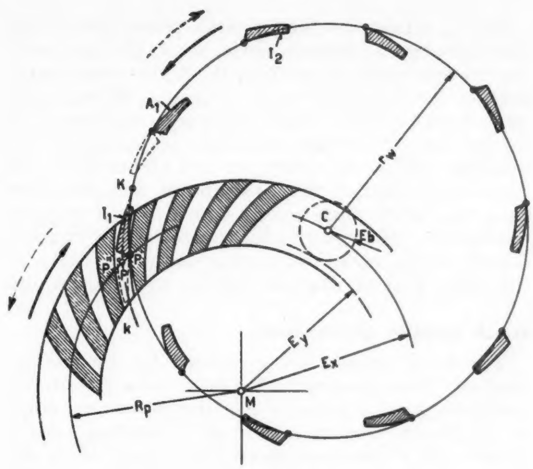


Fig. 1.

A point K of the circle with radius r_w, equidistant from the pitch points of I_1 and A_1, meets the circle with radius Rp at the point P, equidistant from P' and P''. The curve k, which is the path of point K on the imaginary flat gear, is the mean pitch curve.

Since for every cutter revolution, the job rotates by z_w times the pitch (in the case of the figure, every cutter revolution causes the blades to pass through five consecutive tooth spaces), the ratio: blank angular velocity to cutter angular velocity must equal the number of blade groups z_w of the cutter divided by the number of teeth z of the job.

Let a circle with radius Eb assumed solid with the cutter roll without sliding on a circle with radius Ey assumed solid with the imaginary flat gear whose number of teeth is z_p. We get

$$Eb/Ey = z_w/z_p$$

$Ey + Eb = Ex$ being called the eccentricity of the cutter axis.

The circle with radius Eb features the roll circle of an extended epicycloid, the circle with radius Ey its base circle.

The mean pitch curves k, which are identical with the tooth pitch curves in the case shown by the figure, are thus portions of extended epicycloids.

The same considerations apply to the opposite direction of rotation of the tooth and job (dotted blades and arrows), for the same hand of spiral produced on the job. In this case the blade groups cut with the outside cutting blade first.

Fig. 1 also shows that each of the two gear members must be cut by a different cutter, as they have opposite hands of spiral. In the case referred to by the full arrows and blades, and where the blade groups begin to cut with the inside cutting blade, the cutter producing right hand spiral gears rotates counterclockwise, and *vice versa*. It is therefore necessary, when gear pairs are produced, to have a pair of cutters, the one being the mirror image of the other.

Fig. 1, where the blades pitch points are evenly distributed on a common circle, shows the particular case of non-corrected gears without curvature modification for localised tooth bearing. When tooth corrections (profile shift, thickness changes) are carried out and when the radii of curvature are modified, the pitch curves are not identical for the convex and concave sides of the tooth, and also differ from the mean pitch curve, which always remains unaltered. The gear characteristics are studied mainly for the mean pitch curve and particularly for the point P at or near the middle of the facewidth.

tooth profile generation

The tooth profiles are generated by the roulette method. The imaginary flat gear, whose teeth are simulated by the paths of the straight cutting edges of the blades, perform a slow rotary motion, i.e. the cutter axis C revolves about the centre M of the imaginary flat gear at the angular velocity ω_p, while the job rotates at $w_r = w_p Z_p / Z$. This velocity is superimposed, by addition or subtraction according to direction of rotation, to the division angular velocity; which is accomplished by means of a differential.

general diagram

In Fig. 2, K is a mean pitch curve according to Fig. 1. We find also the point P, the roll circle Eb and the base circle Ey of the epicycloid. Fig. 2 applies to most general cases and provides all elements required for establishing the gear and cutter characteristics and the setting data of the generator. It is sufficient to compute all values referring to the mean point P.

The instantaneous centre of the motion (roll of roll circle on base circle) is Mo on line MC connecting the centres of the imaginary flat gear and of the cutter. MoP is thus the normal to the curve K at P, whose instantaneous centre of curvature is O. The angle β_p made by the tangent t, with the mean cone distance Rp, is the spiral angle of the gear at the mean point P, and is usually called the spiral angle of the gear.

It is also evident that, irrespective of the length of the cutter radius ^rM, both the instantaneous motion centre Mo and the instantaneous curvature centre O are always located on a common line through P, and that the cutter centre always lies on a parallel to MoP at the distance E_M.

The lengths ^rM and E_M determine the dimensions of the cutter; the eccentricity Ex must be taken into consideration for setting the generator.

It will be seen that with this system any spiral angle, also zero angles, and any radius of curvature can be obtained. This is helpful when offset (hypoid) gears are concerned, considering the modern tendency towards large offsets and small tooth ratios. Offset gears cannot be obtained correctly without taking into account the interdependence of the various geometrical values, such as, e.g., the angle of the pseudo pitch cones and the radii of curvature of the teeth. Professor Capelle has given a clear demonstration of these relationships in his book "Theory and Calculation of Hypoid Gears".

localised tooth bearing

To obtain localised tooth bearing in the general case of Fig. 2, the procedure is as follows: on one gear member, both tooth surfaces are roughed and finish-cut in one chucking by means of a cutter with evenly distributed blades, so that (except if the teeth are corrected) the pitch curves are identical for both tooth surfaces. The mating gear member is processed by a cutter of the Fig. 1 type, but provided with a larger radius than the cutter used for the first member. This cutter roughs and finishes in one set up the concave tooth surfaces, and roughs and semi-finishes the convex surfaces where only a slight

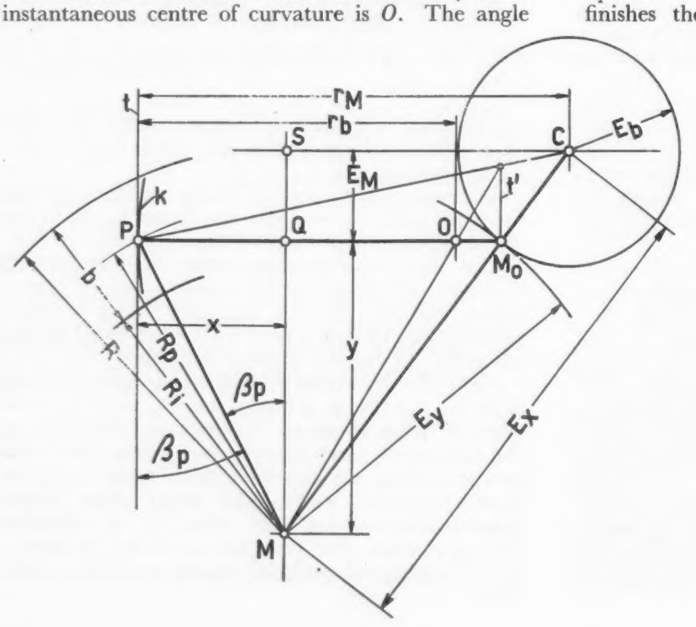


Fig. 2.

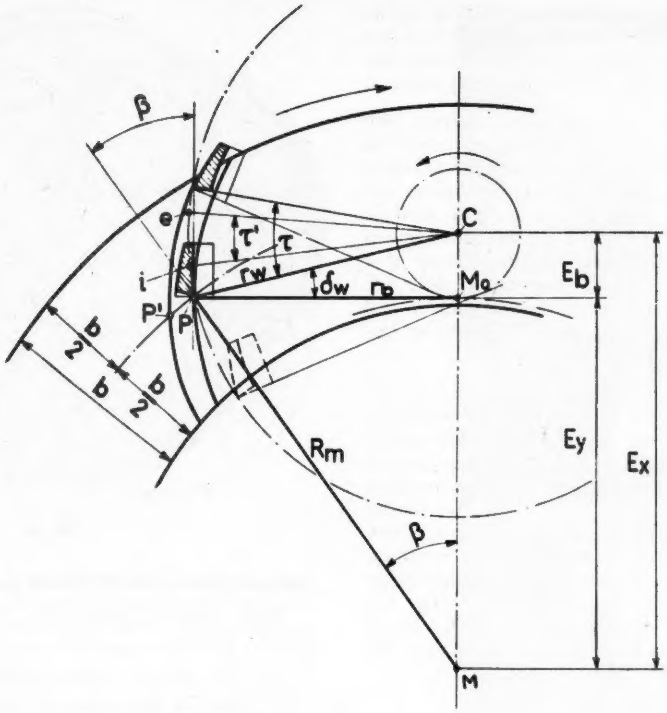


Fig. 3.

d_m = mean pitch diameter

Z = number of teeth of gear to be cut

$m_s = d_m/Z$ = mean transverse module

$m_n = m_s \cdot \cos\beta$ = mean normal module

$Zp = 2 \cdot Rm/m_s$ = number of teeth of crown rack

Zw = number of blade groups of the cutter

$$Rm = r_b/\sin\beta \ ; \ r_b = r_w \cdot \cos\delta_w \ ; \ \boxed{Rm = r_w \cdot \cos\delta_w/\sin\beta} \quad (1)$$

$$Ey/Eb = Zp/Zw = 2 \cdot Rm \cdot \cos\beta/m_n \cdot Zw$$

$$Ey = Rm \cdot \cos\beta \ ; \ Eb = r_w \cdot \sin\delta_w \ ; \ \boxed{\sin\delta_w = m_n \cdot Z_w/2 \cdot r_w} \quad (2)$$

$$Eb = r_w \cdot \sin\delta_w = m_n \cdot Zw/2$$

$$Ey = Eb \cdot Zp/Zw = m_n \cdot Zp/2$$

$$\boxed{Ex = Ey + Eb = m_n \cdot (Zp + Zw)/2} \quad (3)$$

allowance is left; the eccentricity *Ex* is increased in order to keep the instantaneous centre *Mo* on the line *MoP*. A third cutter, with smaller radius than the cutter used for the first member, and provided only with inside cutting blades, rapidly finishes the convex tooth surfaces; the eccentricity *Ex* is decreased accordingly.

This method, which offers no difficulty for large series production with several machines and cutters invariably adjusted for the three operations, is, however, used only for special cases such as gears with abnormal spiral angle and hypoid gears with large offset.

reduced diagram

For normal spiral bevel gears and for hypoid gears with small and medium offset, Oerlikon have worked out an extremely simple and logical system, which permits the cutting of either gear member in one set up with the required amount of crown, i.e. with localised tooth bearing. Size and localisation of the tooth contact pattern on either side of the teeth can be freely adjusted and predetermined by calculation.

Fig. 3 illustrates the principle of the system. It is a special case of the diagram in Fig. 2, in which the point *M* is at the same time the instantaneous motion centre and the instantaneous curvature centre

of the epicycloid; thus the triangle *MOP* is right-angled. Furthermore, the cone distance *OP* and the line *OC* connecting the centres of the imaginary flat gear and of the cutter make the mean spiral angle β.

Thus straightforward relations are obtained (see caption Fig. 3). The angle δ_w, called twist angle of the blades, is the angle between the cutter radius r_w and the radius of curvature r_b. Formula 2 gives the sine of the angle δ_w equal to the normal module multiplied by a factor which is a constant for a given cutter. When establishing the working range of a particular cutter, limits of the normal module are chosen in order to ensure that the maximum and minimum twist angles do not differ by more or less than 1 to $1\frac{1}{2}°$ from the mean twist angle.

The figure shows two finishing blades of a group, of which one produces the convex side, the other the concave side of the same tooth space. The blade shown in dotted lines belongs to the preceding group and has cut the concave surface of the preceding tooth space. The pitch point radii of the two blades make an angle $\tau = \pi/Z_w$ as in the case of Fig. 1, where the pitch points are evenly distributed on a common circle with radius r_w. The pitch point of the inside cutting blade is at *P*, on the circle with radius R_m. When the pitch point of the outside cutting blade meets the circle R_m at point *P'* of the pitch line, the job will have revolved by half the pitch.

localised tooth bearing

Assuming that, all other values remaining unchanged, the angle τ is made smaller and becomes τ', so that the pitch points lie in *i* and *e*.

When point *i* meets the circle with radius R_m, this will take place within the tooth space and at a certain distance from pitch curve point *P*, since both the cutter and blank have meanwhile rotated, i.e. point *i* will be " late ". Similarly, point *e* will meet the circle R_m at a certain distance from pitch curve point *P'*, also within the tooth space, as the gear rotation will not have attained yet half the pitch, i.e. point *e* will be " ahead ".

But if, in addition to reducing to τ' the angle made by the blade radii, the blade pitch point radius producing the convex surface is made conveniently shorter and the blade pitch point radius producing the concave surface conveniently longer, the pitch points will pass through *P* and *P'* respectively. The radius of curvature of the convex tooth surface will now be smaller than the one of the mating concave surface, and localised tooth bearing (crown) is obtained. The angle τ' may theoretically be given any value.

The difference (r_{ba}—r_{bi}) between the two radii of curvature is very closely equal to the length of an arc (τ—τ') of the circle with radius *Eb*.

These considerations are valid irrespective of whether tooth corrections (profile displacement, thickness modification) are carried out. This method defines the ELOID gear type.

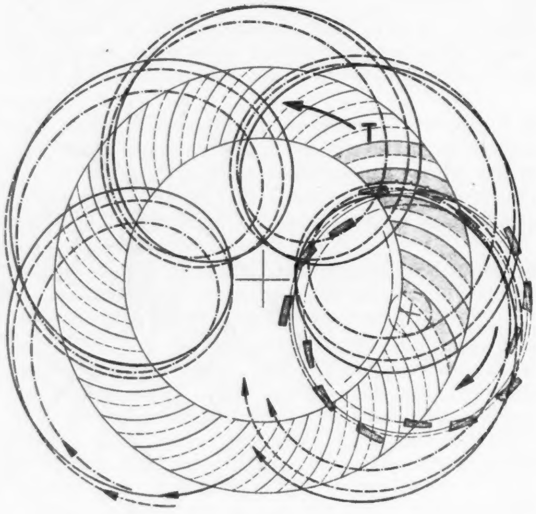


Fig. 4.

salient features of Eloid gears

Eloid gears have the following interesting properties:

(a) the normal module varies very little lengthwise on the tooth, so that the thickness is not far from being constant all over the tooth;

(b) the longitudinal curvature of the teeth is very favourable, their strength being increased by their arched shape;

(c) under load, tooth bearing tends to shift towards the small (inner) end (the toe) of the tooth, where the spiral angle is smallest. Thus the axial thrust for the maximum stress increases to a much smaller extent than in the case of gears where the tooth bearing moves towards the large (outer) end (the heel), where the spiral angle increases rapidly. The tooth depth being constant all over the facewidth, engagement conditions remain favourable. Furthermore, gear cutting can be carried out in such a way that under light load the tooth bearing is located at the heel, where the spiral angle is largest, this causing the contact ratio to be maximum when the gear is expected to run most quietly, a particularly advantageous feature where motor vehicle gears are concerned.

(d) calculations and gear projects are extremely simple; as the tooth depth is constant, tooth corrections are calculated and obtained exactly as for spur gears. There is no module specified; the normal module can be selected freely within the working range of the cutters and the generator.

(e) the production of the gears is very straightforward, as localisation and size of the tooth contact pattern are precalculated and obtained from the start on the soft gears. To compensate for heat treatment changes it is sufficient, as a

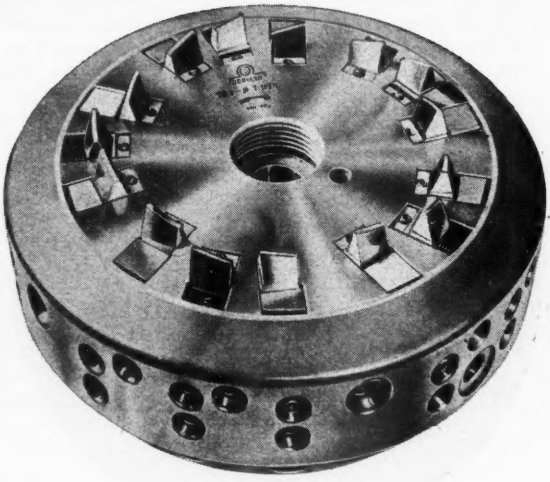


Fig. 5.

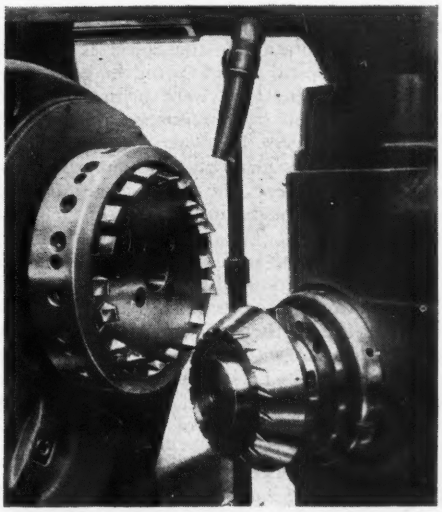


Fig. 6(a).

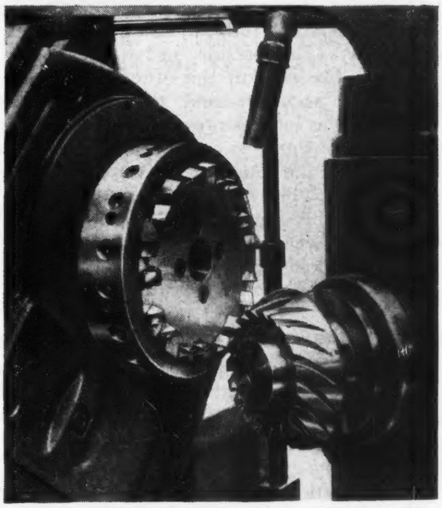


Fig. 6(b).

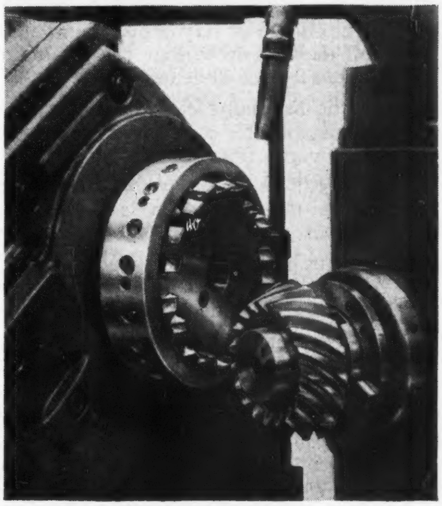


Fig. 6(c).

rule, to correct the adjustment of the generator by the same amounts of displacement, but with inversed signs, which have to be carried out on the testing machine for re-establishing correct tooth bearing localisation.

The gears are produced by means of standard, special and universal cutters. The complete range of standard cutters allows for single job, medium series and large quantity production, for:

cone distance: 60 to 280 mm (about 2 to 11 in.)
transverse module at large tooth end: 2.75 to 13.6 mm
transverse D.P. at large tooth end: 9.2 to 1.8 mm
spiral angle, approx.: 29° to 46°
number of teeth of imaginary flat gear: 20 to 75

cutters for generation throughout

These cutters are designed according to the principle shown on Fig. 4, which is a developed projection of the gear, i.e. the imaginary flat gear, and illustrates the blades in the plane containing their pitch points.

As has been explained before, in order to obtain tooth bearing and thus different curvatures of the convex and concave pitch mean curves, the angular distribution of the blades is not uniform. Furthermore, each group contains a third blade called a roughing blade. The pitch points of all inside cutting blades are on a common circle (full line), smaller than the dash-line circle which is the locus of the pitch points of all outside cutting blades. The roughing blades are theoretically inside cutting blades which arrive " ahead " in each group while cutting; their pitch points lie on the dotted circle, which is still larger than the other two. The figure shows the extended epicycloids described by each blade type.

Fig. 5 shows a standard cutter with three types of blades per group, located in this order (while passing the tooth spaces): roughing—inside cutting—outside cutting. One notes that the tips of the various blades

are arranged on a kind of spiral in each group. The direction of rotation of the cutter is opposite to the hand of the spiral produced on the gear.

Cutters of this type were primarily intended for cutting the blank by generation from the very beginning of the process, as shown by Fig. 6. While the cutter axis slowly revolves about the axis of the imaginary flat gear, the cutter gradually approaches the job and the blade tips farthest off the cutter centre first begin to cut. The cutter penetrates progressively to full tooth depth into the job, the blades farthest off the cutter centre still being the ones which cut deepest. Continuing its generating motion, the cutter traverses the toothed portion of the gear, the blades lose the contact with the job, and the cutting process is terminated. The thickness of the chips removed is a function of the speed at which the cutter axis revolves about the axis of the imaginary flat gear (feed.)

It will be noted that the blades which first contact the blank are, in fact, the roughing blades. They do by far most of the work, which consists in grooving the tooth spaces; they do not need to be set very accurately. The outside and inside cutting blades (finishing blades), on the other hand, must be set with high accuracy and this accuracy must be maintained as long as possible. They work only with their lateral edge, removing a much smaller quantity of stock than the roughing blades, and are thus much less loaded. The roughing blades wear much faster than the finishing blades, but they can be re-sharpened several times before the finishing blades need resharpening; thus only one third of the cutter blades are subject to the greatest wear.

disadvantages of generation throughout

The system consisting of cutting the gear teeth from start to finish by generation has the following disadvantages:

(a) the amount of roll (rotation of roll cradle) greatly exceeds the amount actually required for generating the tooth profile (arc of action of the imaginary flat gear in mesh with the gear to be cut). For very flat crown wheels the total roll may be up to four times the amount required for actual generation.

(b) at the beginning of the cut, the blades work in unfavourable conditions; the thickness of the chips varies from start to finish of the process.

(c) the gear being cut from outside towards the centre, deburring is more difficult than when the burrs are obtained at the periphery.

(d) the tips of the roughing blades, which do most of the work, are farthest off the cutter centre and have thus the greatest cutting speed.

(e) When pinions are cut, the tendency prevails for the job to be pulled out of its mounting.

cutters for combined plunge-cutting and generation

In order to obviate the aforementioned disadvantages and at the same time speed up production and prolong tool life, Oerlikon have developed a new

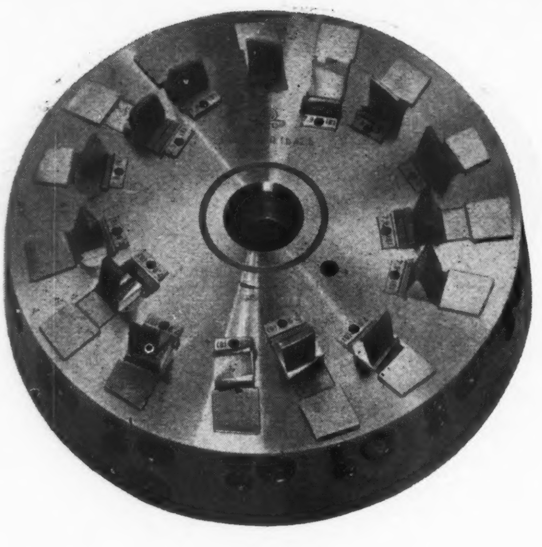


Fig. 7.

cutting method which consists of dividing the process into two distinct and consecutive phases, while still maintaining the principle of producing the gears in one single cutting.

During the first stage the rotating cutter, whose axis is stationary in space (roll cradle at standstill), is imparted an axial infeed motion which grooves the tooth spaces. As soon as the cutter has reached the right depth, the infeed motion stops and the second phase begins, i.e. the roll cradle starts rotating. This roll is limited to the minimum required for generating the tooth profile; the start and finish of the roll correspond exactly to the beginning and end of the arc of action of the imaginary flat gear in mesh with the gear to be cut.

For the application of this process and for obtaining the best results, a series of standard cutters has been designed, specially suited for the plunge-cutting method. The direction of rotation of these cutters is the same as the hand of the spiral produced on the gear, i.e. opposite to that of the cutters intended for generation throughout.

Fig. 7 shows such a cutter. The order of succession of the blades of each group while passing the tooth spaces is: roughing—outside cutting—inside cutting. The roughing blades are theoretically outside cutting blades which arrive " ahead " while cutting; they are nearest the cutter centre and their cutting speed is thus the lowest. As a result, for an identical gear and with the same cutting speed at the tip of the roughing blades, the rotating speed of a plunge-cutting cutter can be 10 to 20% higher than that of a cutter designed for generation throughout.

During the plunge-cutting phase, all blades work under the best cutting conditions; the roughing blades only with their tip edge, the finishing blades only

with their lateral edge (inside or outside). The finishing blades are much less loaded than the roughing blades, as they remove chips whose thickness is only about one third of the chips removed by the roughing blades. The accuracy obtained on the gears is higher, since the machine operates with a greatly reduced power during the generating phase. The blades cut from the inside towards the outside of the gear, the burrs form where they are easiest to remove. When pinions are cut, they are pushed against their mounting.

Cutters designed for generation throughout can also be used for plunge-cutting and with excellent results, whereas the cutters designed for plunge-cutting cannot be used for generation throughout. Indeed, if such a cutter approaches the blank tangentially, the roughing blades will never touch the blank, as they lie at the shortest distance from the cutter centre.

A detailed study shows that with the new cutters considerably more stock is removed during the plunge-cutting phase than while generating, thus ensuring a better distribution of blade wear and a higher accuracy of the tooth profile. The same study proves also, geometrically, that it is utterly impossible logically to distribute the plunge-cutting operation over several roughing blades in the same group. Since each of these blades would necessarily be located at a different distance from the cutter centre, an exact distribution would only be possible at one point of the facewidth and for only one position of the cutter relative to the job (position of the roll cradle); at all other points, one of the blades would be loaded, to a greater extent or less, than the others, or could even possibly work alone, or not at all.

advantages of the new standard cutters

The new series of standard cutters for combined plunge-cutting and generation have the following advantages. The working range is the same as for the previous series, but, additionally, different amounts of crown, i.e., various tooth bearing lengths, can be obtained with each cutter size. Various types of roughing blades can be mounted on the same cutter according to tooth space, for minimum wear of the finishing blades. The finishing blades may also be shaped so as to produce a slight undercut at the bottom of the pinion tooth flanks, an old and well-known expedient (for which letters patent were granted to the S.A. des Automobiles Delahaye-Belleville in 1914) for preventing load concentration at the corners of the crown wheel's teeth at the beginning of the contact and indentation on the pinion teeth flank while lapping. The pressure angle is usually $17\frac{1}{2}°$, but blades for other pressure angles can also be supplied.

For very large series, particularly of hypoid gears, it is advantageous to use cutters specially designed for maximum output.

universal cutters

The universal cutters, adjustable throughout but provided generally with only three blades per cutter, are very handy for trials, prototype gears, and piece-work. Their output is lower than that of the standard cutters.

Spiromatic No. 2 generator

With the Spiromatic generator, spiral bevel gears with an outer cone distance up to 280 mm (in certain cases even up to 305 mm) and hypoid gears with an offset up to 90 mm can be produced. The outer cone distance must not be less than 50 mm. Fig. 8 shows the machine.

rules for gear projects

For Eloid gear projects the following rules should as far as possible be observed; they are, by the way, more or less the same for all gear systems:

Number of teeth: in principle 5 (or even 4) up to more than 100. Normally, the number of teeth of the imaginary flat gear should lie between 25 and 70.

Facewidth: normally $^2/_7$ of the outer cone distance, must not be more than $\frac{1}{3}$ of same.

Constant tooth depth: normally 2.15 times the normal module, plus 0.35 mm.

Spiral angle: according to permissible thrust and to stress calculation. May vary from 29° to 46°; 37° is the average. We have already seen that for Eloid gears a larger spiral angle (2° to 6° more) can be selected than for large radius cutters (for gears with circular tooth curves), since the tooth bearing shifts towards the toe of the pinion under load, where the spiral angle is smallest. The hand of the spiral is usually chosen so that, for the main direction of rotation, the thrust tends to shift the pinion away from the centre of the gear.

easily established projects

The Oerlikon Machine Tool Works hold folders and simplified instructions at customers' disposal, permitting the rapid preparation of preliminary projects which may need only slight modifications in due course when the exact gear calculations are carried out.

applications and cutting time examples

Spiral bevel gears are used for general engineering purposes and pre-eminently for the rear axles of automotive vehicles. Many vehicles are already equipped with Oerlikon Eloid gears, hypoid as well as spiral bevel. The cutting times required by the Oerlikon combined plunge-cut and generation method are extremely short. Because gears and pinions of spiral bevel gears and of hypoid gears with medium offset are always produced in one operation (only the pinions for large offset hypoid gears need usually two operations), the floor to floor times are obviously shorter than with methods requiring several operations.

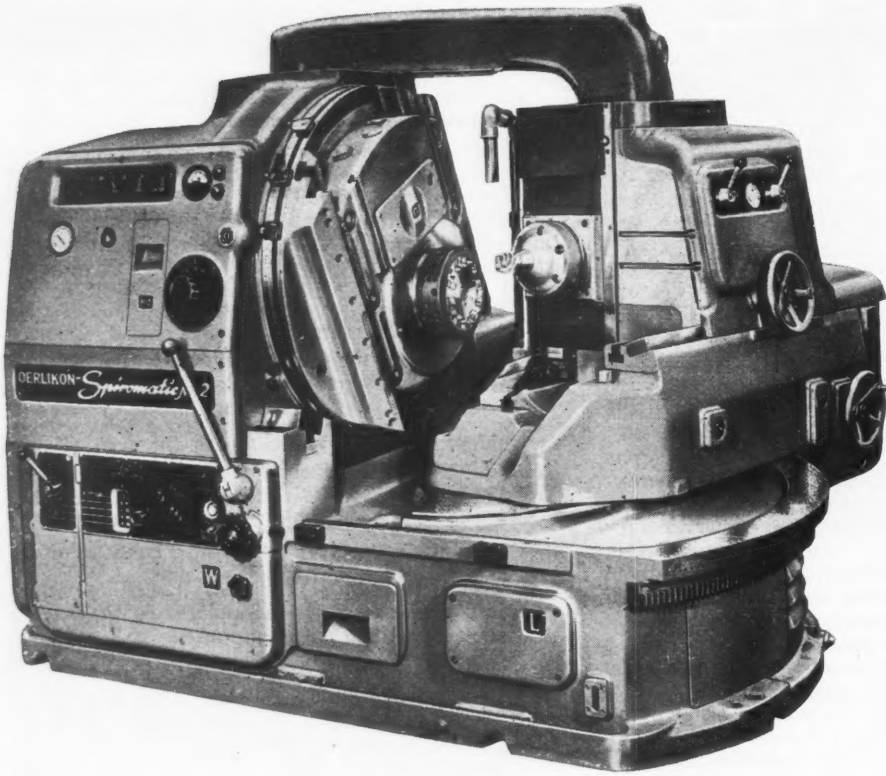


Fig. 8.

As a first approximation of the cutting time (machining time) of rear axle gears one may assume: Total cutting time for the crown wheel in minutes $= {}^{4}/_{100}$ of the outer crown wheel diameter in millimetres.

Total cutting time for the pinion in minutes $= \frac{2}{3}$ to $\frac{3}{4}$ of the time for the crown wheel of spiral bevel gears (intersecting axes).

Here are a few examples:

(a) 7:33 spiral bevel gear for sports car
module 5 mm, i.e. 5.08 D.P.
gear dia. 165 mm, i.e. 6.50 in
facewidth 23 mm, i.e. 0.9 in
cutting time:
gear, 5.8 minutes, i.e. 10.6 sec./tooth
pinion, 4.0 minutes, i.e. 34 sec./tooth

(b) 10:39 hypoid gear for passenger car
module 4.4 mm, i.e. 5.76 D.P. (for crown wheel)
gear dia. 172 mm, i.e. 6.77 in
facewidth 26 mm, i.e. 1 in
offset 32 mm, i.e. 1.26 in
cutting time (2 cuts for the pinion):
gear, 6.2 minutes, i.e. 9.5 sec./tooth
pinion, 7.5 minutes, i.e. 45 sec./tooth

(c) 8:43 spiral bevel gear for lorry and bus
module 7.8 mm, i.e. 3.26 D.P.
gear dia. 335 mm, i.e. 13.19 in
facewidth 44 mm, i.e. 1.73 in
cutting time:
gear less than 15 min., i.e. less than 21 sec./tooth
pinion, 11 minutes, i.e. 82.5 sec./tooth

(d) 9.44: spiral bevel gear for tractor
module 7.6 mm, i.e. 3.34 D.P.
gear dia. 325 mm, i.e. 12.79 in
facewidth 45 mm, i.e. 1.77 in
cutting time:
gear, 14 minutes, i.e. 19 sec./tooth
pinion, 10 minutes, i.e. 66.7 sec./tooth

All these times are those actually needed for the required gear quality and economic tool life conditions.

In most cases, gears for lorries and tractors do not need lapping.

electronic computers and the production engineer

by P. V. ELLIS, A.C.I.I.

Summary

This Paper commences with an appreciation of the two most important extra facilities which may be obtained from the use of an electronic digital computer system. These are quite fundamental considerations showing that a computer provides more than the simple clear cut speeding up of arithmetical processes which have previously been carried out by manual methods or other forms of mechanised accounting. The Paper continues by describing a typical electronic computer designed from the outset to deal with commercial and industrial accounting rather than for scientific calculating. This description is limited strictly to considerations of logical design and the results which may be obtained, rather than of the hardware inside the computer, taking due note of the maxim that " it is not necessary to know how a watch works to tell the time ".

The application of such equipment to the preparation of weaving schedules from original orders in a textile mill is used to illustrate one method of dealing with the general problem of parts and material scheduling and stock control.

In conclusion there is an appreciation of some of the effects on management of the introduction of faster, more comprehensive control information.

AN electronic computer does not merely carry out the arithmetical processes of addition, subtraction, multiplication and division more rapidly. A machine capable of such operations, however quickly they are achieved, is normally designated a calculator. The principles of two of the important extra facilities provided in an electronic digital computer now to be dealt with, are illustrated by examples which are deliberately taken outside the context of Production Control.

This has been done so that when the main routine dealing with placing orders on a textile mill is encountered, the principles will be familiar and exclusive attention can be given to their application.

(a) *decision making*

Suppose that the readings taken from electricity or gas meters are recorded by means of holes in standard sized pieces of card (i.e., punched cards). Information which does not normally change from one quarter to the next quarter, e.g., name and address of the consumer, the number of meters on the premises, average quarterly consumption, etc., is automatically brought forward and associated with the variable details of the meter readings.

Fig. 1 shows the sequence of steps which are carried out in part of a single shot operation through a computer. It can readily be seen that the amount of actual calculating is very limited compared with the number of times that comparisons are made against predetermined (or calculated) criteria. According to the result of each comparison, completely different later action is taken. In other words, the computer is making a series of decisions. Analysis of the way

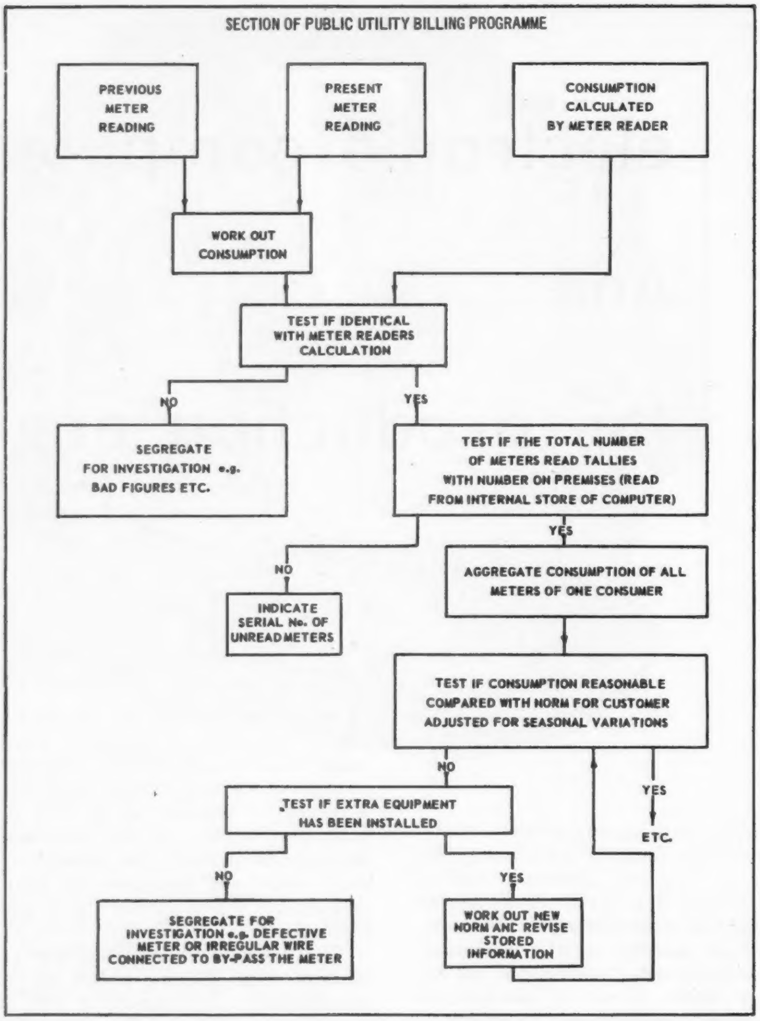


Fig. 1.

the individual steps are used in a computer programme reveals that only 10% are actually doing arithmetic and the other 90% are used up in organising the data and sending it along different paths according to the nature of each item.

It is axiomatic that provided the criteria for any judgment can be stated explicitly, however involved these criteria may appear to be *prima facie*, then it will be possible to instruct a computer to carry out the same operations. It is essential that the complete routine is broken down into a series of simple single items, each one of which involves only one addition, one multiplication or one decision with a Yes/No answer. The preparation of a flow diagram of the type illustrated is not essential, but it is found in involved routines to impose a discipline in investigation which pays off in arriving more rapidly at a running system which really does everything required of it.

A further point which is cognate to decision-making stems from the fact that a computer will carry on faithfully applying the rules exactly as they have been formulated. In practice, one of the things which skilled Organisation and Methods men try to guard against is the disintegration of an excellent system by continual small amendments of procedure, carried out by those unfamiliar with the overall picture and hence unable to appreciate the overall effect of piecemeal changes.

A computer programme should certainly be regularly reviewed and amendments to the original requirements included. In addition, any defects discovered in the system in the light of running experience should be incorporated. This work can and

must be done, however, by those fully aware of the purpose of processing the data and cognisant of the cost of obtaining information and balancing this against the value which will be obtained from it.

(b) *modification*

Modification is the ability of a computer to change its own instructions according to a predetermined plan. The best way to describe this is to illustrate how it is used. Fig. 2 illustrates a punched card containing the details of Time ON and Time OFF for each day of the week from Monday to the following Sunday. The times are recorded in hours and minutes in exactly the same way as on a clock card. There is an indication when the time is p.m. The rule book for wages payment shows that if a man attends for duty at all on any day, he will be paid for 8 hours. If he works between 8 and 10 hours, payment will be at time and a quarter, if between 10 and 12 hours it will be at time and a half, and if over 12 hours it will be at double time. In addition, " dark money " at the rate of time and a quarter is payable for duty between 10 p.m. and 6 a.m. A combination of overtime and dark time attracts a cumulative combination of extra pay.

A series of single steps, similar to those shown in Fig. 1, can be drawn up commencing with the subtraction of two times expressed in hours and minutes, going on to calculate the notional hours (payable hours) and finishing with their evaluation.

The rule book also covers a multitude of other contingencies such as working on rest days, working on Bank Holidays and so on. When all these factors have been taken into consideration, the number of separate operations which are required to be carried out on the times shown for each of the seven days is considerable.

However, the only difference between the operations to be done on Monday and those to be done on Tuesday is the different set of clocked times. Thus, if it can be arranged to carry out the identical set of operations just bringing in the successive variable clocked times for each day, a more economic machine can be made. The ability of a computer to carry out repetitive processes, but bringing in new data, is termed " modification " and this ability has made it possible to construct a medium-priced machine capable of handling very large jobs, in which a repetition of the same pattern of operations is carried out on varying data.

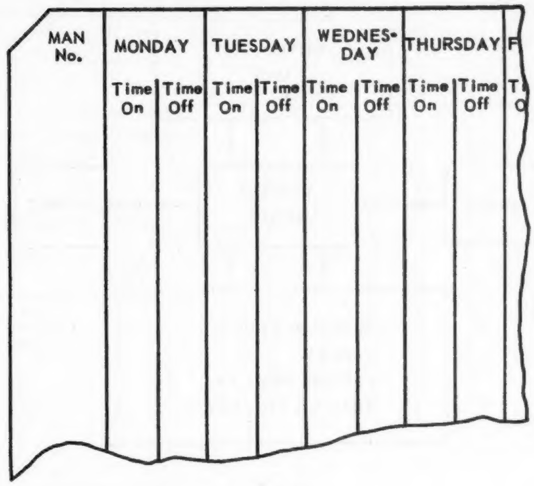


Fig. 2.

considerations in the design of a computer

Fig. 3 shows the elements of all electronic computers. If the computer is to do the routine work of a clerk, then it must obviously possess all the abilities which the clerk uses in carrying out his routine work.

Mr. Ellis was educated at Manchester Grammar School. During the War, he served in the Merchant Service as a First Radio Officer holding First Class P.M.G.'s Certificates in Radio and Radar. He has a number of years' practical experience of office mechanisation in insurance, and on the theoretical side he obtained the Jubilee Prize for the best Papers submitted in the Chartered Insurance Institute examinations.

This was followed by the preparation, installation and day-to-day running of an integrated punched card production control scheme with concomitant stock control, labour dissection and payroll bonus schemes in a light engineering works.

In 1952, he joined Powers-Samas Accounting Machines (Sales) Ltd., as Manager of the Computer Group, which covers the programming and application of medium scale computers and large scale integrated electronic data processing systems.

Mr. Ellis has presented a number of Papers on the commercial and industrial application of electronic computer systems, including one on production control in light engineering to the London Section of The Institution of Production Engineers in March, 1956.

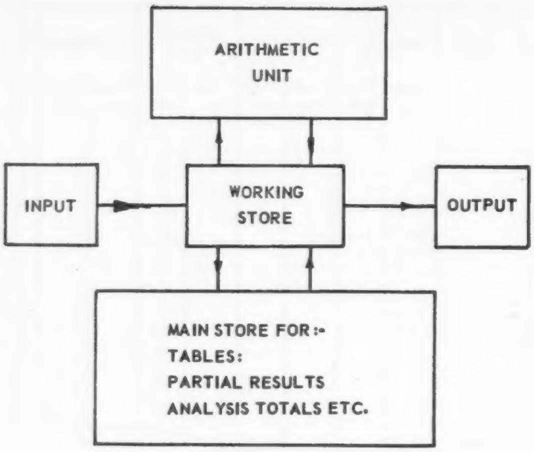


Fig. 3.

The working store corresponds to the sheet of paper on which the clerk jots down his intermediate results. The arithmetical unit corresponds to a desk calculator or to the calculator that the clerk carries around under his hat. The clerk has long-term storage in the form of tables and other written information. He gets papers from his " In " tray and when they have been dealt with they go into his " Out " tray. Thus all the functions are allowed for in Fig. 3, except the knowledge of how to use each of them to cause the input data to be correctly processed through to the finished result. In other words, a very precise series of instructions is required to provide the equivalent of the overall control of the clerk contained in his memory and his references to the rule book.

Computers are instructed to carry out very simple operations only and far from being " electronic brains " they are, in fact, more like high speed morons. The types of operations shown in each box of Fig. 1 can be carried out at the rate of 1,000 per second, but all the possible decisions and all the possible circumstances, however remote, must be anticipated for every case and the programme written accordingly.

As an example of the care required and the attention to detail necessary, consider the following point in isolation, which occurred in a recent programme prepared in the author's group to evaluate the actuarial liabilities of a pension fund. The year of birth provided in the input information was used to calculate the age attained by the life at the date of valuation. If no year of birth was available (this being a comparatively rare occurrence) certain other less accurate assumptions were made automatically in the programme. In order to save time in the preparation of the original data, only the last two digits of the year of birth were recorded.

The computer programme, which blindly followed the series of instructions, tested the year of birth for zero value and in each case that zero was found the special assumption routine was called into operation instead of the normal procedure. This same thing happened, however, both for those cases where no year of birth was recorded and for the cases of employees born in 1900, which to the machine looked identical because of the lack of the initial two digits.

Tracing faults of this kind can be a troublesome task. Part of the skill in preparing the series of instructions (or programming) is in anticipating that such things inevitably arise and making provision for finding them rapidly by sectionalising and isolating different blocks of the routine.

The difference between one computer and another is in the emphasis which is placed in each upon the size and speed of operation of each of the separate functions shown in Fig. 3. Scientific computers are generally required to carry out a large volume of calculating upon a very restricted amount of input data resulting in few answers. To solve a system of linear equations with 100 unknowns, for example, may require 100,000 multiplications. The input for this work could be contained on only 200 punched cards with the results being recorded in just two punched cards. Suppose that an extra £20,000 spent on a basic machine would either increase the speed of multiplication five-fold or would increase the input/output speed 20-fold. The best throughput speed of matrix solution would be obtained by applying the extra money to hardware for the arithmetic unit, because the biggest portion of the total time is spent in calculating.

Most commercial and industrial data processing requirements have the opposite characteristics. The volume of input and output is large, but the calculations required on each item are not extensive by scientific computing standards. In this instance, it will be more profitable to expend the extra £20,000 on the provision of faster input and output or on the ability to deal with several streams of input information simultaneously.

The first electronic computers were designed with the whole emphasis on speed of calculation, neglecting input and output. Consequently it is not surprising that their use in the commercial field was only a qualified success, because although they certainly did the job of work put to them, the overall cost was too high.

Having dealt with the inter-relationship between the speed of input and output and the speed of doing arithmetic, it is necessary to consider the size of the internal store. Consider, for example, the number of characters (alphabetical descriptions and numerical information) relating to the bill of materials for one sub-assembly containing perhaps 20 compounds. This will include such details as whether they are bought out or manufactured, the quantity and description of the material in each and the standard time and the description of each of the operations in their manufacture. A total of 10 million characters corresponding to 50 million (say) binary digits would only deal with a moderate number of sub-assemblies. The provision of internal storage of this fantastic amount of information is possible and has indeed been done. The

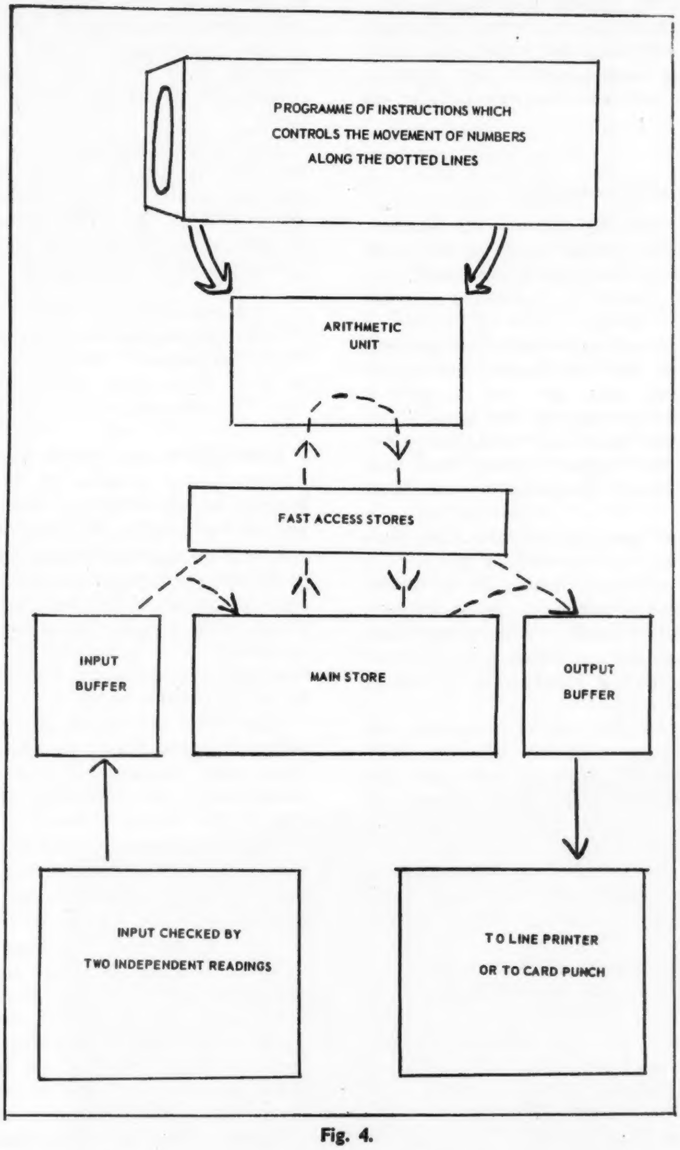


Fig. 4.

hardware that is at present available, however, is very expensive.

There are two feasible alternative approaches.

The first of these is magnetic tape. This can be read and written at speeds up to 15,000 characters per second. A great deal of information can be recorded in a small space. In fact, one cubic yard of magnetic tape spools can contain the same amount of information as 100 cubic yards of punched cards. Magnetic tape is the best medium at present available when associated with a large organisation and an extensive computer control centre. Such an installation is, however, quite expensive ranging from £140,000 to £300,000 for the equipment only.

The second medium is punched cards. This cannot be processed as rapidly as magnetic tape. In large files of "permanent" information such as the one referred to above, where reference at any one time is only to a proportion of the total information, the speed of extracting such information manually is not very different from the speed of scanning the whole magnetic tape record. There is, therefore, a balance between the higher cost of magnetic tape equipment with greater potential output and more automacity in operation, against the lower cost of a punched card computer system with lower speed and more manual operations and more opportunities for errors to be made.

It was found after the systems investigation in a small group of textile mills that the second approach utilising a punched card computer system was more appropriate. A brief description of this type of computer is now given and then the details of the job itself.

punched card controlled computer

The schematic diagram (Fig. 4) shows the relationship between the various units. The input is read from each punched card and stored temporarily in an input buffer store which is contained on one track of the magnetic drum.

The punched card is read again at an independent second sensing station and the second sensing is automatically compared with the first to give a complete check of the accuracy of the input data. As each result is worked out in the arithmetic unit, it is channelled to the output buffer store and retained until the whole programme has been completed.

The results are either punched into the card from which the original input was obtained, or are printed out directly on a line-at-a-time printer. If the results are punched, it allows the output to be sorted and possibly collated with other cards — containing names and addresses, for example — before being printed out on a separate tabulating machine operating at 300 lines of print per minute.

In different models of this type of computer, the internal storage varies in capacity between 1,000 digits and 20,000 digits. In either of these cases the use of the internal storage is to hold factors and tables of rates, etc., particular items of which are selected by the requirements of each item of the input data. It will also be used to keep running totals and analyses for accounting control purposes. The storage is not, however, large enough to keep all the balance information.

Thus, in designing a system involving such a computer it is arranged for the internal storage to be loaded with a selection of information which is then used for computing. As soon as the results have been worked out and recorded, a new selection of information is read in replacing the previous block. The medium from which this balance information is read is, of course, a file of punched cards.

The method of arranging the data outside the computer in such a way that it is possible continually to load, use and replenish the limited internal storage is illustrated in the following actual example.

textile factory control

This routine is concerned with a group of mills weaving cloth of different widths, qualities and designs sold primarily for making up into garments.

The orders from customers are received mainly in batches two or three times a year, corresponding to the fashion house collections for the coming season.

The overall object is to plan the weaving of the required cloth in a timely and economical way. In particular this will be aimed at avoiding the production of cloth before it is required, which would involve unnecessary capital on the one hand, and ensuring that it is not produced too late, with consequent loss of orders and goodwill on the other hand.

The prime document is the order, which specifies the quantity, quality, colour, and design of the cloth and the month in which delivery is required. Some orders will specify a part delivery of the total order in each of several months, e.g., an order for 10,000 metres placed in April may show :

Month of delivery			*Quantity in metres*
September	...	...	2,000
October	...	...	4,000
November	...	...	3,000
December	...	...	1,000

Some orders are placed specifying the number of "pieces" of a number of different standard piece lengths. In the following description, the quantities will be expressed in the standard unit of metres.

It will be apparent that a simple preliminary part of the computer programme has been allocated to the multiplication of number of pieces by length per piece. This length per piece for all the possible variations is a factor which is stored within the computer and extracted by means of a code number for the particular order.

The looms on which the cloth is woven are of different types. Some are capable of weaving wide cloth with complicated woven design. These are, incidentally, also controlled by a type of punched card in the Jacquard looms.

This original use of the punched card is believed to have influenced Dr. Hermann Hollerith in his invention of the punched card machinery for use in the United States Census of 1890.

Other looms are only capable of weaving plain and coarser cloth. Although the more versatile loom can also weave the plain cloth, its capital value is very much higher and the maximum profit is only made if the loom is weaving the best and highest value cloth for which it is designed. Nevertheless, it will generally be better to weave lower grade cloth than none at all.

There is thus a nice problem in determining the best method of allocating orders to available capacity in order to achieve most economic production, and hence the maximum profit.

The first requirement is to divide the weaving capacity into types, depending upon the type of cloth which can be woven at maximum profit. The code numbers for each cloth annotated on the orders contain within them digits which relate to the same groupings. Thus the type of loom to use for any particular cloth is immediately available from the code number associated with the cloth. The time taken to weave a particular length of cloth depends upon the number of shuttle movements to be made. The length of cloth in itself is not a sufficient measure. The available capacity is shown, therefore,

as the number of shuttle movements which are available in each period.

It is known that there will be a regular demand for many cloths. Stock orders are placed on the factory for these at the appropriate time. These will show the quantity to be produced each month and the loom capacity taken up by these orders will be subtracted from the total available capacity.

Thus there are two large files of information. One contains the loom capacity expressed in terms of shuttle movements for each loom group. The other contains for every type of cloth the stock which will be on hand and is not bespoke.

One method of relating incoming orders against these two files would be to store all this information internally in a computer. As each order is to be dealt with, the appropriate figure of stock and loom capacity would be found. The internal storage necessary for the purpose would be considerable.

an alternative method

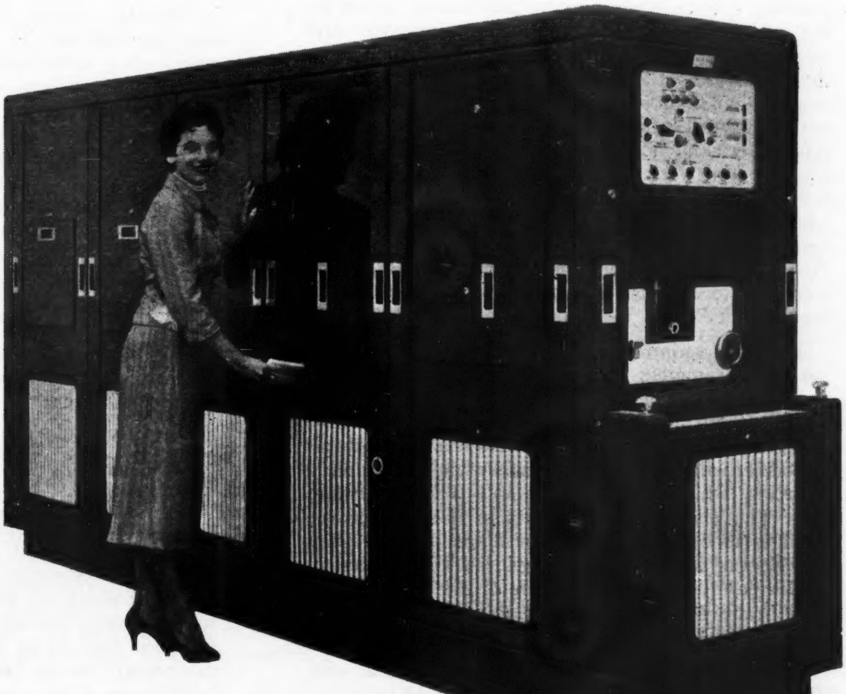
An alternative method is to punch cards for each loom group giving available capacity, and to punch cards for each type of cloth giving quantity required and when required. This card will also contain the number of shuttle passages to weave one metre of cloth. It will be seen that after the setting up of the initial records by manual punching or by marking cards for subsequent processing by a mark sensing machine, there is no further manual preparation of balance figures.

The cards will be sorted together, so that each loom group master card is immediately followed by the stock cards for each of those cloths which is woven on the particular type of loom group. Furthermore, the stock cards are themselves arranged so that those cloths on which the profit is highest are first and those where the profit is lowest are dealt with last.

This file of cards is collated with those containing the new orders which are automatically inserted in the appropriate places next to the stock card of like number.

The resultant composite file is passed through the computer. The details of the available loom capacity are transferred from the master card to the internal storage, where they will be retained during the time that the allocation of orders takes place within the particular group.

The information from the first stock card is then similarly stored and the first order for the particular cloth is read into the computer. The stock which will be available in the first month is compared with



This electronic digital computer works with punched cards. It does all the necessary calculations to determine the amounts to go in each pay packet at the rate of 30 pay packets per minute.

the order. If there is sufficient stock, then the balance of free stock will be reduced and the balance of allotted stock will be increased by a like amount. If there is not sufficient free stock, then the balance is shown as available in the previous month and then if there is still not sufficient free stock, the balance in the second previous month is tested and reduced accordingly. If none of these three balances is sufficient, action is taken to institute a new order on the looms. The order, or order balance, is compared against a minimum economic quantity to manufacture. The difference between the new order required and the minimum quantity, if the order is less than the minimum quantity, is carried forward as free stock available for the next order.

The quantity required on the order — or the balance of the order if some stock was available — is turned into terms of shuttle movements by extending the shuttle movement per metre by the quantity required. The figure obtained is tested against the available loom movements in the month under consideration and then successively in the previous two months. The same procedure is run through for the orders for each successive month. Similarly, the cards relating to the orders for the next type of cloth in the loom group are processed. The locations in the internal storage for the stock balances are being continually changed as each set of balance is read in, compared, processed and read out to make way for the next balances.

At the completion of the computer run, those punched cards containing new orders to be placed on the factory will be automatically segregated and listed out. In the same way those cards which show that all available loom capacity has been exhausted in a particular period of three months will be printed out for special action. This will take the form of a policy decision as to whether it is possible to sub-contract the work depending upon the size of the orders, or to work a certain amount of overtime, or whether to weave the cloth on a more expensive loom with reduced profit. It may be instructive at this moment to consider the possibility of asking the computer to work out the answer to questions of this type.

The first requirement will be to determine the various parameters on which the decision is to be based. This will include an estimate of the reduced efficiency during the day as a result of overtime working, if overtime is worked over a considerable period. It will also include details of sub-contracting capacity, which may be available at some future date. The really onerous task is in formulating the input in precise terms when there are imponderables the effect of which cannot be ignored. If quantitative values can be found for each of the factors, the computations to give the best solution are not too difficult.

To summarise, the smaller computer will deal with all the routine comparison of stocks, plant capacity, etc., throwing out items of exceptional interest and retaining the others within the system. It does so at the expense of auxiliary operations of sorting and collating to process items sequentially rather than in parallel. The use of a computer, whether large or small, to help with the management decisions on the exceptional items could only be considered if more work is put into formulating in quantitative terms the various parameters involved.

The first stage in dealing with a routine of this nature is the mass processing of a great deal of data, each block of which is dealt with in the same way. Those items requiring special attention are brought out from the system and printed out.

This facility for automatic *data screening* permits the skill and judgment of senior clerical staff to be applied more efficiently and avoids the waste of scanning hundreds or thousands of entries to discover the few which require action.

appreciation

1. A good production control system attempts to utilise the productive capacity of a given plant in the most economical manner in order to maximise profits.

   However, the application of production control procedures and techniques requires a large volume of clerical work. This volume of work slows down the control operation so much that a great deal of the information is presented to management too late to be of value.

   The chief clerical problems in connection with production control arise when the original production schedule has to be changed because of engineering modifications, or changes in anticipated sales volume. If the production schedule cannot be revised to reflect frequent changes in engineering and sales requirements, production control may degenerate to a point where flying squads of progress chasers attempt to cope with a series of continual crises.

   The revision of the production control programme at frequent intervals is one of the challenges that electronic computing equipment is capable of meeting.

2. The result of being able to process more raw data to provide summarised results more quickly has a number of facets.

   If timely results are not available, it is necessary to make each management decision without giving full weight to some essential or desirable detail. If the right short-term decisions have been made based on incomplete data over a period, a time will inevitably come when, as with the Sorcerer's Apprentice, action has been taken the results of which are difficult to stop. For example, suppose extra manufacturing capacity has been obtained because of increased total demand and due regard has not been paid to cyclic trends and breakdown of the total demand, owing to lack of timely relevant information. It may be that sales and profits will increase temporarily, but in the

(*concluded on page* 95)

The Diploma of Technology Scheme

A Progress Report to the Council of
The Institution of Production Engineers
at the October, 1958, meeting
by SIR WALTER PUCKEY, Past President,
and Chairman of the Board of Studies in Engineering,
National Council for Technological Awards

IT is some time since I last gave the Council a report on the progress of the Diploma of Technology scheme, and it has been thought fitting that I should give you an account of my stewardship as your representative on the Hives Council, so that you may know the latest situation so far as this scheme is concerned.

The last time that I reported progress to you it was under the heading of "What is meant by practical training ?". At that time Mr. Pryor said that my talk covered neither practical training nor the Dip.Tech scheme. To avoid his castigation on this occasion I propose, first of all, to give you a purely factual survey of the progress made since I last spoke to you. If you are not satisfied it is rather late in the day for you to say so, because it has recently been agreed that I should serve as your representative for a further period of three years! Whether or not at the meeting next month I shall be reappointed Chairman of the Board of Studies in Engineering I cannot say, but as your representative I have been on the National Council for three years and I believe that very considerable progress has been made during that period.

I do not intend to go over the reasons for the setting up of the Hives Council or the Dip.Tech.; you know the background as well as I do. Since the inauguration of the Hives Council we have paid about 45 visits to colleges and I have been present at most of them. We have so far approved 17 of those colleges, or about 40%. That sounds a very low figure, and one particular case was commented on by one of our members this morning. Some of you know very well the reasons why we have been able to approve only 17 out of the 45 colleges. It has been for a variety of reasons, some of them given in the Paper which I read at Harrogate a year or more ago dealing with the progress of the scheme.

We have in these 17 colleges approved 65 separate courses for specialisms such as mechanical engineering, electrical engineering, production engineering, chemistry, physics and so on, including industrial mathematics. We have rejected 85 courses, and again the percentage of approval is lamentably low.

A breakdown of the different technologies represented by our approvals was circulated to this Council, covering the period up to the end of February last. Quite a number of changes have taken place in the last month or two in regard to approvals and the setting up of new courses, and on the next page, para. 4, are tabulated the various courses, starting with aeronautical engineering, the number of courses, and the students in the various years of the courses. The number of courses is given there as 40, but today it is 65. You will notice that mechanical and production engineering are given together, but the number of production engineering courses is very small ; there are only three or four. All of these figures are related to February of this year, and the number of students engaged on the various courses in the various years had then reached a total of 1,360.

You will note the division between full-time and sandwich of the various students in the various years. The percentage of sandwich students out of the total is high and is tending to increase.

NATIONAL COUNCIL FOR TECHNOLOGICAL AWARDS

STATISTICS (as at 6th February, 1958)

1. Courses now in progress: 40 courses from 11 colleges.

2. Number of courses in engineering and other technologies now in progress:

Dip.Tech.(Eng.) = 22 courses
Dip.Tech. = 18 courses

No. of students enrolled

	1st year	2nd year	3rd year	4th year	TOTAL
Engineering	528	302	117	40	987
Other technologies ...	208	130	35	—	373
	736	432	152	40	1,360

3. Number of full-time and sandwich courses now in progress:

Full-time = 7 courses
Sandwich = 33 courses

No. of students enrolled

	1st year	2nd year	3rd year	4th year	TOTAL
Full-time	48	46	—	—	94
Sandwich	688	386	152	40	1,266
	736	432	152	40	1,360

4. Courses now in progress, and number of students enrolled, under subjects:

Subject	*No. of courses*	*1st year*	*2nd year*	*3rd year*	*4th year*	TOTAL
Aeronautical Engineering ...	2	25	—	—	—	25
Applied Biology	1	6	—	—	—	6
Applied Chemistry ... ... Chemical Technology ... ... Industrial Chemistry	7	69	46	9	—	124
Chemical Engineering	2	9	2	—	—	11
Civil Engineering	1	5	7	—	—	12
Electrical Engineering	8	235	151	72	40	498
Mechanical and Production Engineering	9	254	142	45	—	441
Metallurgy	3	34	35	6	—	75
Mathematics	2	18	—	—	—	18
Physics	5	81	49	20	—	150
	40	736	432	152	40	1,360

So much for statistics bearing on the numerical progress of the scheme. A landmark was achieved in August at the Birmingham College of Advanced Technology, when the first students who were studying for the Diploma of Technology entered for, and in a number of cases passed, their final examination. This is an honours standard examination and, therefore, one would expect to have the larger percentage of those passing achieving an honours standard. Out of the 40 candidates in the honours course at Birmingham, all in electrical engineering and all sandwich students, there were three first, 25 seconds and seven passes. There were five who failed. We consider this to be a highly satisfactory state of affairs and an important landmark in this new educational award.

encouraging efforts

I would like to comment on the situation which we have found as we have gone round the country. It would be foolish to deny, in the face of the many failures by colleges to satisfy the Hives Council, that things have generally been satisfactory. Great efforts have, however, been made by many colleges to improve both the colleges themselves, in terms of staff, buildings and equipment, and the actual content of the courses. We have received great encouragement from educationalists generally. By and large we have received considerable encouragement from industrialists as well, and it is appropriate to remind you here that the Dip.Tech. scheme is one in which a combination of encouragement and help from colleges and industry is very important, much more so than in any other award of that nature and standard.

I would like also to mention the encouragement and help the Hives Council has received from the universities, and this has been particularly important and significant during our recent studies into the creation of a higher award. A report will shortly be issued which will explain this important matter in some detail *, and I shall not anticipate it, although I do want to mention the implication of the proposed higher award on industry, that is, on many members of this Institution.

Before I do so, however, I want to mention one other important decision which the National Council has just made, and that is to set up a Committee to investigate the whole problem of practical training. It is the view of many of us that if we were to visit most of the companies in this country and study them in the detail in which we have studied the 40 odd technical colleges in relation to their responsibility, the majority of the companies would fail to pass our test. That is a sad reflection on the state of practical training during this formative period in the career of the students, and in a scheme such as the Dip.Tech., with its emphasis on a balanced educational course of theory and practice, it is surely only right that industry should face its obligations in the same way that we expect the principals of colleges to face their obligations.

I hope that this Institution will help the Council in this extension to our work. Any investigation into the industrial half of training involves the goodwill and active assistance of industry, and the professional bodies. I was interested to hear this morning that you are considering setting up an *Ad Hoc* Committee to study practical training in greater detail. I strongly support this move, and hope that we can help each other.

Finally, may I return again to the problems and possibilities of a high reward, and in the Council agenda I posed several questions that I would like you to consider. Within the last two weeks the Hives Council has approved the final details of a higher award, and these will be announced in about a week's time at a press conference *. Many colleges have been pressing us to come to a decision on this question of a higher award. Some of you may say that it is a little premature, bearing in mind that only in the last month or so have the first results of the diploma course been made known, and most of the other students will not take their final examination for some time. Nevertheless, when making one step it is a very good idea to consider the implications of that step in relation to the future. We have done that. We set up a special committee to investigate the question of higher awards, and we have now approved the details, which will be made known shortly.

What are the reasons for instituting a higher award ? I assume that it is not necessary to explain to you, and that you in fact accept, the implications of the Dip.Tech. itself. I should like to quote something said by our President in his Paper at Olympia entitled " Some Problems of Higher Technological Education ". We are very fortunate in our President, who has given great intellectual stimulus to our activities. You will find in this Paper many valid reasons for paying much greater attention, by this Institution among others, to the subject of higher awards in technology. Almost on the last page of that Paper there is a sentence which supports the President's earlier arguments for the encouragement of more people to obtain a higher award. He said :

> " The engineers who are to hack their way through the jungle of difficulties presented by developments of the type which I mentioned " — 75,000-ton presses and the like — " will need a broader scientific background than their colleagues engaged on maintenance, line production or design outside the field of essential novelty. This cannot be provided within the framework of a three-year degree course and a two-year apprenticeship."

I wholly agree with the arguments which the President used and the reasons he gave for suggesting that much greater attention may well have to be paid, particularly by industry, to the setting up of higher awards and the facilities for attaining them. The Hives Council fully supports, for these and other reasons, the setting up of one such higher award.

* *" An Award Higher than the Diploma in Technology." Published by the National Council, October,* **1958.**

* *See page* **95.**

essential requirements

What are the essential requirements of such a higher award ? Let us re-examine the essential differences between the Dip.Tech. and a degree, which will help us to appreciate the differences between the Council's higher award on the one hand, and a Ph.D. or M.Sc. or something of that nature on the other. Although there are not as yet many production engineering courses approved for the Dip.Tech., a strong emphasis in Dip.Tech. courses is for the achievement of a happier marriage between theory and practice. Approval is granted only if the right balance between the practical and the theoretical is achieved. We want that to be true also so far as the higher award is concerned.

The F.B.I. recently said that industry tends to be critical of what is considered to be the unduly large number of university graduates proceeding to higher degrees, taking the view that these outstanding graduates would benefit both themselves and industry by entering employment on obtaining their first degree. In many cases, we believe that to be true ; we believe that there should be a consolidating period in industry after the student has obtained his Dip.Tech. In most circumstances, therefore, we would expect a period of several years in industry before going on to study for the higher award. That is different, of course, from what happens in many of the research and special studies at universities.

industrial application

Secondly, industrial application of the research work must be considered of paramount importance. We are not concerned only with research into a precise engineering or technological subject, but would consider that research into, for instance, marketing, would be equally valuable if it called for a high degree of disciplined, skilled investigation, and was of industrial value. We consider the field to be very wide, covering industry and commerce as a whole, but we do emphasise the value of industrial application. Our President used words to that effect in his Olympia Paper.

The National Council feels, too, that the student should be industrially-based. By that we mean that he should base himself upon a particular company and should go from that company and back to that company. We believe that the college should set academic standards and maintain the academic disciplines involved in the student's research project. Our President referred also to this requirement, and he implies in his Paper that it is very doubtful whether many companies can create and maintain an intellectually disciplined atmosphere in which investigations of this nature can be successfully carried out for such a length of time. I believe that to be true. As an industrialist, I would say that the mental discipline we are expecting among people doing this sort of research is not maintained, or even attained, in a large majority of the companies of this country. Too often I hear young men who have gone to a university or to a technical college saying : " It is a soft option when I go back to the company compared with the disciplines I am expected to maintain at the university or college ". I do not believe that it should be a soft option, but however much we strengthen our industrial standards, the technical colleges which are approved for administering the higher award must themselves set the academic standards and make certain that the intellectual discipline of the project is being maintained.

an imaginative title

I will not anticipate our report by telling you of the suggested title for this higher award : I hope that you will find it imaginative and something which will lead to new opportunities in this important field.

At the risk of over-stepping my brief, I should like to spend a few more minutes talking about the implications of the Dip.Tech. proposals to our Institution. You may feel that I, as your representative, have relatively failed in my job because there are only three production engineering courses approved out of the 50 or 60 courses which have been approved by us so far. I have personally been faced with extreme difficulty when examining the large majority of the production courses submitted to the National Council for approval. There is at least one person on this Council who is in charge of one course which has been approved, and he will not mind my saying that the subject of production engineering has much to learn from more established courses, particularly in a definition of the content, a consistently high level of discipline, and a correspondingly high level of staff.

There are very good reasons for these existing deficiencies, and again I would refer to our President, who has described in clear language some of the problems which we in this Institution face today. He referred only this morning to a Paper which he read before us and which was published in the Journal last May, called " Technical Training and Professional Status ". Among many other wise things in that Paper, he said that " production engineering differed from mechanical engineering in the sense that the number of topics which have been dominated and reduced to intellectually good order was smaller, so that they did not as yet form a broadly based subject on which a university degree can be awarded ".

It might be said that there are too many production subjects to be able to do that, that the field of production engineering is so large that we need whole rows of shelves full of different packages on them, in order to display our wares. This is too simple an answer, and in any case it is wrong. The more topics we drag in and assume to be part of production engineering, the more we may weaken our case by not being able to treat or teach the subject as a comprehensive whole or as a comprehensive discipline. It is probably true that our Institution has a greater problem than many others because of the wide nature and scope of production engineering. It is probable that we may have to provide a wider range of alternative and optional subjects around the basic core of production engineering. We are, for instance, concerned not only with technology, but with human

beings. and when one surveys the vast new fields of control, communication, automation and the like, one envisages an even further extension to our interests and our responsibilities.

production technology

I am sorry if I appear to know the questions more clearly than the answers, but surveying our future from my vantage point I believe we might with advantage think of our future more in terms of production technology rather than production engineering. It may be that a rose by any other name is still full of thorns, but I would ask you not to rule out the possibility or desirability of changing our name or looking on our work more in terms of a technology than of an engineering activity. It is not without significance that two of the most interesting courses which have been submitted to the National Council recently have been production courses leading to the Dip.Tech. and in each case the colleges have used the term " production technology " deliberately and not as a result of any pressure by us. They are two of the most interesting production courses which we have seen. We have spent much time on these courses and have finally come to the conclusion that they are very sound and of great interest to the National Council and, indeed, to this Institution ; we shall be interested to see the sort of fellows who will emerge from these courses.

It is also not without significance that one of our leading colleges, the Northampton College of Advanced Technology, has decided to expand its production department, and call it the Department of Production Technology and Control Engineering. That title is a deliberate attempt to bring in more of what has recently been claimed by at least one distinguished scientist to be a new primary technology — control engineering. Here is an important college where a new approach is being tried, and I believe that the department will achieve strength and status in years to come far greater than anything which could be attained only by an expansion of its existing production engineering department.

Perhaps these trends are only straws in the wind, and you may not consider them important in relation to the general problem of the Institution ; I believe they are very important, and I mention them because we are here thinking of the future, and these problems are particularly important.

Finally, Mr. Chairman, how many members of Council will raise their hands when I ask how many present have entered students for Dip.Tech. courses ? I see three or four hands raised, which is not a high percentage. There is an approved course in production engineering in the Midlands which this year, despite all the efforts of the Principal and his staff, has only three entries. This certainly means that personal attention will be accorded to each one of the students, but that is not the way to look at it ! The National Council and the colleges have established many courses, but there still remains the essential factor of continued practical support by industry. We are doing our best on the National Council and, I, as your representative, am doing my best, to set up a new technological framework of real worth. The technical colleges of this country, in terms of staff, equipment and buildings, are having millions of pounds put into them. I believe that we are on the eve of a great renaissance so far as technical college education is concerned ; but let us see that we in industry match up, and face up, to these standards.

Mr. L. S. Pitteway said that it would be necessary to give guidance to industry. Many of the faults of colleges and industry were the result of ignorance of what was required. It was not sufficient to tell colleges that they did not reach the required standard ; they must be given evidence which would be of use to them, because the spending of ratepayers' money was involved. Had Sir Walter any suggestions to make there ? Could the colleges be told that they would be given information which would afford a basis for improvement, and that industry would be guided where it required guidance ?

Sir Walter Puckey replied that there was need and opportunity for a happy combination, perhaps not yet fully achieved, of local and national guidance. Most colleges tried to satisfy local requirements, though it would be realised that a number of the colleges were now being raised to a status where they had a national status, as compared with the purely local one of the more junior colleges. It was desirable for certain colleges to continue developing specialist courses, of which they were proud and for which they were well-known, and in those cases there might be specialist groups of people to advise them. He had been struck by the increasing attention which was being paid to the setting up of advisory committees in the various colleges, very often national rather than local in character, so that nationally known and expert people could give the sort of guidance required by a college of higher status. Members of the Institution should be encouraged to sit on such committees, which, in his view, should have a wider industrial representation than was often allowed. Some of the governing bodies and committees were much too narrow in membership, and were controlled too much by political strength.

At the national level the Hives Council was setting up a committee, as he had said, to deal with the question of practical training and to try to give the sort of advice which Mr. Pitteway had in mind, bringing the standard of practical training to the same level as the theoretical standards, which had been examined in such great detail in the colleges. It was the intention of the National Council to provide better guidance, but the Institution also had a special interest and should itself conduct an investigation and give the considered view of the Institution. The Institution of Mechanical Engineers had recently issued a report on one aspect of practical training. A great deal more thinking had to be devoted to this matter. The period of a Dip.Tech. course, of four or five years, had to be regarded as a continuous process of education and not as a sandwich where some of the parts were almost uneatable and

the others full of good meat. It must be a sandwich which was attractive all the way through.

Mr. G. R. Pryor said that the new Dip.Tech. was a jump forward and not merely a natural development of the educational system. It would be interesting to hear from Sir Walter what was envisaged for the next stage. Mr. Pryor was a little concerned about the concentration on mere academic content in the educational process. It would be very interesting to know to what extent academic qualifications had counted in the case of people who had been really successful as production engineers or industrialists. He was not belittling it or attempting to say that it was possible to do without it, but did the practical training side of the Dip.Tech. attempt to supply what was missing in providing the ability to handle people, and that sort of thing? If so, how was it examined and assessed in awarding the Diploma ? On the purely academic side, was Sir Walter satisfied that the present examination system was adequate ? Was it really a test of a man's ingenuity and ability to handle a situation, as distinct from being largely a test of memory ?

Sir Walter Puckey remarked that Mr. Pryor had raised at least four important points. The first was whether there was too much theory and not enough practice in the course. The Dip.Tech. scheme was intended to provide a happy marriage between theory and practice. While many members of the Institution were proud of their ability in many ways to transfer theory into practice and to be good " practical men ", with all that that implied, they were entering a world where more new and complicated technical tools were available, and they had to know of the existence of those tools and how to use them.

He would like to take a simple example from materials handling. He had had occasion a year or two ago to write to Miss Bremner and to suggest that the Institution should not have printed some of the case studies in materials handling which had appeared in the *Journal*. They might have been practical examples of materials handling, but they were crude in terms of a disciplined approach to the problem, and the Institution could have been criticised for publishing stuff of that kind. The subject was one which could and should have involved a greater amount of theoretical examination and operational research. He believed it was the task of the Institution to breed more men who knew " why ", as well as knowing " how ". To know why meant that they had to understand to a much greater extent than in the past the theoretical advances which were being made, and how to use them for practical advancement.

With regard to ability to deal with human beings, it should be borne in mind that in the Dip.Tech. course they were concerned with men at the undergraduate stage. Sir Walter hated the sight of the word " management " in any Dip.Tech. course, and did not think that the students were ready for it at that time. There were many contributory aspects which led up to management later on, but the students for the Dip.Tech. were young men, young in age and young in relation to handling human beings and dealing with management problems. Despite the attempt to liberalise and humanise their studies, the basic object was to enable them to learn their trade, which was a combination of theory and practice. Every Dip.Tech. course contained liberalising elements, which it was hoped would encourage students to see their own specialist studies within a wider framework.

That led him to the question of examinations. In the Dip.Tech. scheme great care was taken in appointing external examiners, who provided that external, objective analysis of the results, of the examination papers and the standards. The examiners were approved by the National Council, who were naturally concerned about examinations as well as the standard of entry ; good material was coming in, and they wanted good material to go out, assessed by the most modern methods. He could not tell Mr. Pryor of any fundamentally new examination procedures, but he was certain that the great care taken by all concerned would ensure the best results within our present knowledge of examination procedures. There was much to learn in our assessment of results, and even the universities would admit that they had a great deal to learn. The importance of the point made by Mr. Pryor was appreciated.

Dr. T. U. Matthew said that Sir Walter's report on progress gave ground for great encouragement. The Institution had backed the Hives award from its inception, and great progress had been made in the colleges so far. It was not confined to the colleges ; it was notable that a good deal of thought was being given to the subject outside the colleges and in many walks of life the sandwich scheme approach was regarded as new and desirable. He heard more and more comments in that sense, and he thought that this was largely due to the activities of the Hives Council and to the undoubted success of the colleges which it had approved and which were carrying out the Dip.Tech. scheme.

The only cause for some slight disappointment was the small number of production engineering courses which had actually been approved. This followed what had been experienced previously in technical colleges during the introduction of production engineering as a Higher National Certificate subject. It was, therefore, necessary to look more deeply, as Sir Walter had indicated, at the roots of production engineering. Could it become more clearly recognised as a disciplined group of subjects based on the scientific approach ? Attention must be paid to this matter if production engineering were to become recognised as an approved course under the Dip.Tech. scheme in all the colleges in this country.

Sir Walter, in his excellent report, posed a number of questions on research. Dr. Matthew was delighted to see that after three short years the stage had been reached of looking ahead to see what was to follow on the Dip.Tech. course. The first question

asked was what form of research was particularly appropriate for holders of Dip.Tech. first degree to engage upon. What was the object of engaging in this activity ? It was well known in the university world, and it would gradually become recognised in the college of technology world, that one of the important objects of going on from a recognised course of studies to engage upon research was to learn the research approach. The first year of the research work was one devoted to not much more than learning how to do research. That was all that there was time for in the first year, to show the student how to use his thinking and apply it, what were the research tools, how to apply scientific discipline to new problems.

Dr. Matthew suggested, therefore, that the form of the research was less important than bearing that object in mind. The first year of research should contain suitable teaching on the subject of how to approach research problems and what methods of analysis were appropriate to a research subject. The subject of research chosen should be a very practical one, particularly if it was for a higher award in production engineering.

The subject of production engineering was very wide, but there were certain basic approaches, and he had in mind particularly what had become known as the operational research approach, the application of a particular scientific method of approach to any operating situation. It did not matter much what was the particular process being studied ; it was the study of the total situation and the elegant application of advanced techniques of analysis which had a broadening effect and which could lead to the type of thesis by which it was possible to judge whether a man had mastered the art of research and was able to present his results convincingly or not. The operational research type of project should be high on the list of acceptable projects for post-graduate research.

The second question was : " What is the optimum length of time necessary in this research ? ". University experience indicated that it could not be less than one year, but might well, for what might be described as the lower of the higher awards, be not more than two years. University experience should provide a good guide in this connection.

The third question was : " How appropriate is it for the particular piece of research to be linked direct to the company employing the advanced student ? ". It was not at all essential, and in saying that Dr. Matthew spoke from experience. Companies which were prepared to encourage students to undertake advanced studies of a research nature were generally prepared to say : " So long as this man is trained in research methods, we do not wish to limit his studies to a particular project ".

That led to the fourth question : " Would it be considered appropriate for the research project to be selected entirely by the particular college responsible for awarding the higher degree, thus making it presumably necessary for the student to conduct most, if not all, of his research work in the college itself ? ". Dr. Matthew could speak about this from experience. It would, he suggested, be appropriate for the research project to be selected and agreed with the student and with his sponsoring company on a round table basis. That was particularly true in production engineering, and it made it a joint enterprise. The question of whether it was necessary for the student to conduct most, if not all, of his research work in the college depended on the teaching content of the research years as much as on the facilities of the college to provide him with what was necessary. There were groups of companies which had quite powerful research organisations, even in production engineering, and there were bodies such as PERA which could undoubtedly furnish the laboratory or other facilities which a university or technical college could well agree would be acceptable if the student were under proper supervision there for a research year or two, so that the position in this respect should, in his view, be left flexible.

The fifth question was whether it would be better to start with a lower higher award, having in mind a higher higher award at a later stage. To that his answer would undoubtedly be " Yes ".

Mr. J. France, commenting on what Sir Walter Puckey had said about the number of production engineering courses which the National Council had turned down, said that in his own case there had been attacks on the high standard which they had fixed for their examination, and it was necessary to kill this idea that production engineering was a soft option. In practice the task fell on a very small number of people engaged in technical education. There were many others who had this " soft option " concept and who could do production engineering a considerable amount of harm. That would probably continue until there were more people technically qualified to go much further with the teaching of production engineering and who could solve the problems which Sir Walter had mentioned. It was because Mr. France was so well aware of the difficulties that he welcomed the project for a higher award, because that could afford the training ground for the people who could carry the matter further forward. The Institution and the profession were lacking in people who had taken studies to the higher degree level in their own subjects. The more of these higher courses there were, the better it would be for the production engineering profession.

At Loughborough they had not what might be described as the materials handling package. He had never felt convinced that materials handling had as yet attained the status of an intellectual discipline so that it could be rightly included as a subject at Dip.Tech. level.

With regard to practical training in industry, his own experience had been that industry had welcomed the co-operation of the college and had even gone so far as to allow the college to say what industry ought to do. He had avoided that, because he felt that in a partnership there should not be a sleeping partner, but he had never found any difficulty in getting the

full co-operation of industry in adjusting their own training programmes to fit in with what the college would like to see done.

Loughborough was not the college to which Sir Walter had referred which had only three entrants for the production engineering course. At Loughborough they had more than 33, and that was largely due to their very close co-operation with industry. The biggest difficulty was with the small firms employing only a few people, who found it difficult to make any arrangements.

With regard to the five questions asked by Sir Walter Puckey, and with which Dr. Matthew had dealt so ably, on receiving the Council Papers Mr. France had thought that there would be some opportunity of influencing the statement to be made by the National Council, but apparently it was already prepared for publication. He would make a very strong plea for a lower higher award, because the colleges also had to grow up, and they would grow up more quickly and effectively if they dealt with the "lower" higher award before tackling the "higher" higher award.

Sir Walter Puckey remarked, in case it should be felt that, having posed some questions about a higher award, the answers had previously been determined, that those questions would be as alive after the end of next week as they had been before. The National Council had arrived at certain decisions, but it still remained to work them out, and all five questions would be very pertinent in the future.

Dr. Matthew had referred to the time which might be involved in studying for the higher award. At the moment, the National Council had in mind that the time involved for the first of the awards which they were considering was likely to be not less than three years.

Thanking Sir Walter for his excellent address, the **Chairman** (Mr. H. W. Bowen, O.B.E.) said that great progress had been and was being made, and greater progress could be anticipated in the future.

CO-OPERATION WITH POLISH SOCIETY OF MECHANICAL ENGINEERS

IN April and May, 1958, the Council of The Institution of Production Engineers established friendly relations with the Production Engineering Section of the Polish Society of Mechanical Engineers, and an exchange of visits between the two Institutions took place (see the Secretary's Report, September, 1958, Journal).

An invitation has now been received from the President of the Polish Society of Mechanical Engineers to any members of the Institution who may wish to visit Poland in 1959 to take part in one or other of the conferences which the Polish Society has organised.

Members who wish to attend any of these conferences will be very welcome to present a Paper, or just to participate as conference members. The dates and subjects of the conferences of which the Secretary has been notified are as follows :-

1. February, 1959, in Poznan : General Meeting of the Machine Tool Section (two-day Conference). "The Problem of Appliance of Cutting Tools."
2. May, 1959, in Poreba : Third Machine Tool Conference (three-day Conference).
3. 22nd May, 1959, in Krakow : Scientific Session in connection with the 10th anniversary of the Machine Tool Section (two-day Conference). "Metal Cutting and Electroerosic Finishing."

visits of Polish engineers to Great Britain

The Council of S.I.M.P. is wondering if it is possible for members of the Polish Society to visit Great Britain for period of 6 to 12 months to work in English factories in order to gain practical experience. Any member who would be willing to receive a Polish engineer into his organisation is requested to inform the Secretary at Headquarters, stating terms and conditions on which such a visitor would be received.

The Council of the Institution has been in communication with the Foreign Secretary on the subject of relations with Poland. He is in favour of arranging exchanges of this kind with Poland and considers it will be a useful contribution to the attempt now being made by the Poles to obtain a degree of independence.

"Finding The Practical Solution"

A Report of the

Materials Handling Convention,

Brighton, 13th-15th October, 1958

THE delegates attending the Annual Convention thought that it was the most successful gathering the Materials Handling Group Committee had organised to date. The programme was devoted entirely to the examination and solution of specific practical handling problems which had been presented by 10 local firms, representing a typical cross-section of manufacturing industries in Sussex.

Thirteen of these case problems were investigated by delegates divided into syndicates of five, each syndicate examining one project.

The Convention itself was preceded by a meeting of Section Representatives of the Materials Handling Group, on the opening evening, Sunday, 12th October. At this meeting each of the Section Representatives present reported on the work their Section had done during the past year. Particularly good progress had been made in Manchester, the Western Section, and in Leeds. In Manchester there had been bi-monthly meetings at various members' firms ; lectures had been presented, and a short course on Materials Handling had been arranged at Oldham Technical College. Moreover, all members of the Manchester Section of the Institution had been circulated advising them that the members of the local Materials Handling Group would be willing to assist in any handling problems in individual companies. So far, they had received one request for such advice.

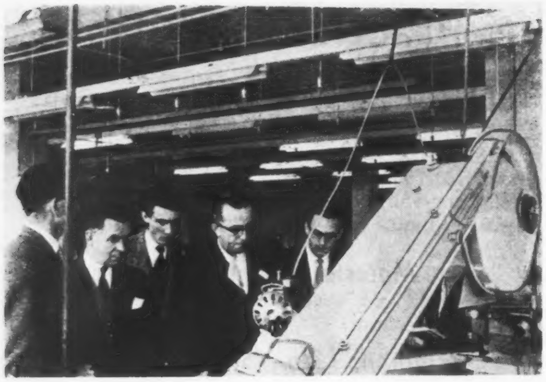
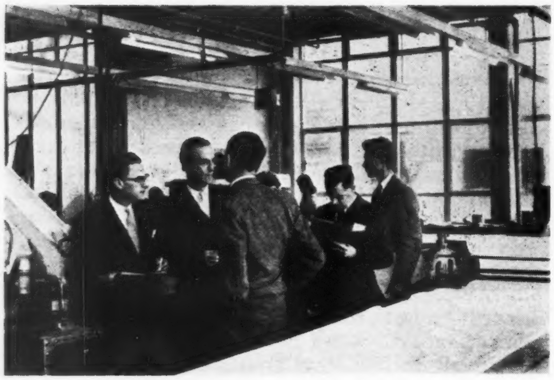
Councillor A. J. Sadler, J.P., the Mayor of Brighton, replying to the Toast of "The County Borough of Brighton" at the Convention Dinner. On his right is Major-General K. C. Appleyard, C.B.E., Past President of the Institution; and on his left is Mr. A. G. Hayek, then Chairman of the Materials Handling Group.

Section activities

In the Western Section, two major factory visits had been carried out by members of the Materials Handling Group, and a considerable programme of further factory visits had been arranged. Two case studies had been carried out and submitted for publication in the Journal. The Group were particularly interested in "Packaging as an Aid to Materials Handling" and had brought along to the Convention examples of the type of containers they were studying in this connection. These examples were exhibited in one of the main meeting rooms and created much interest.

The Leeds Section had made five factory visits during the year, devoted to a study of "Handling of Bar Materials in Long Lengths", and further visits had been arranged. Four films on Materials Handling had been presented at a special meeting, and other shows were in course of being arranged. Two case studies had been prepared for publication in the Journal. The Group had arranged a special programme of three Papers on Materials Handling for the Leeds Section Meeting on 13th October.

Similar progress reports were made by Section Representatives from Sheffield, Swansea, Derby and Shrewsbury. The Chairman congratulated these active Sections on their work and thought that their example would provide great encouragement to the other Section Committees.

Syndicate C 14, who were studying the problem of handling small articles for batch and mass production, are seen collecting information at the Portslade factory of Kayser Bondor Ltd.

The meeting of Section Representatives was followed by the opening of the main Convention, when the delegates were informally received by the Chairman of the Materials Handling Group in the Hotel Metropole, Headquarters of the Convention. The proceedings on Sunday evening concluded with a briefing of the syndicate leaders.

On Monday morning, the syndicates moved off to the 10 factories in the district who had submitted the 13 projects for study. The entire day was spent in those factories, examining cases on the shop floor, and conducting first discussions with executives of the host firms.

the Convention Dinner

The Convention Dinner was held on Monday night. It was preceded by a Civic Reception by the Mayor of Brighton, and the Chairman of the Materials Handling Group Committee. Leading executives of the host firms joined the delegates for the Dinner, and the Group Committee were especially delighted to have Major-General K. C. Appleyard, C.B.E., a Past President of the Institution, as one of their guests. The Guest of Honour at the Dinner, Mr. C. Metcalf, Managing Director of E.M.I. Electronics Ltd., responded to the Toast of "The Guests" with a witty and topical speech, proposed by Mr. A. G. Hayek, Chairman of the Materials Handling Group Committee. This was followed by a Toast to the County Borough of Brighton, proposed by Mr. F. E. Rattlidge, with a response by the Mayor of Brighton, Councillor A. J. Sadler.

On Tuesday morning, syndicates met individually and concentrated on the preparation of their reports. It was most encouraging to see the serious enthusiasm with which each team tackled its project. On Tuesday afternoon, syndicates met in four main groups to present their reports. Group A dealt with the syndicates concerned with the handling of containers, cases and packages. Group B covered projects on the handling of large articles for batch production. Group C dealt with the handling of small articles for mass and batch production; and Group E comprised the syndicates who had studied problems of handling induced by materials of awkward shape. A rapporteur had been appointed for each Group and assessed the effectiveness of project-analysis and case-presentation of each syndicate.

The Tuesday evening was nominally a free period, but most delegates appeared to devote it to polishing up their reports and to exchanging opinions on their respective projects. Informal little groups could be seen all over the hotel in earnest discussion, until the early hours of the morning.

the plenary session

Wednesday morning saw the concluding session of the Convention, at which each of the four rapporteurs in turn presented their Assessment Reports to a plenary session of all delegates. Their able presentation and constructive criticisms were greatly appreciated, and this was followed by a lively discussion from the floor.

Delegates expressed their approval of the way in which the Convention programme had been arranged and it was thought that a practical working conference of this type was of much greater benefit than the more usual one devoted to lectures, presentation of theoretical Papers, and non-purposive factory visits.

A.G.H.

Enquiries regarding the activities of the Group should be addressed to:

THE GROUP SECRETARY,
MR. I. B. KING,
10 CHESTERFIELD STREET,
MAYFAIR, LONDON, W.1.

A NEW HIGHER TECHNOLOGICAL AWARD

IT was recently announced by the National Council for Technological Awards that, in order to encourage qualified men and women to undertake further study beyond the level of the Diploma in Technology and to carry out original investigations, they have decided to create an award higher than the Diploma in Technology. Their intention is that this award shall be a mark of outstanding distinction granted to a student who has proved his ability by completing a substantial programme of work demanding the application of his knowledge to the solution of a problem of value to industry.

The Council will establish a college of technologists, to be known as The College of Technologists, and the new award will take the form of membership to this College (M.C.T.).

To qualify for this new award a student must undertake a programme of work to be carried out jointly in industry and at a technical college. This programme may be concerned with any technological aspect of industrial activity, such as research, development, design, production or market investigation. The Council believe that to carry out successfully post-diploma work of this character, students must remain in contact with industry or with commercial laboratories. Indeed, they are of the opinion that they should not create higher awards which would have the effect of removing a technologist from contact with industry for a considerable period of time immediately after he has gained the Diploma in Technology or an equivalent first qualification.

Before starting on such a programme, a student must apply to The College of Technologists, through the technical college at which he will study, to be registered as a candidate. The College will consider particularly the qualifications and experience of the student, the suitability of the programme offered and the arrangements to be made for carrying out the work both at the technical college and in industry.

The programme offered should be related to the student's personal experience in industry and must have the approval of his employer. Its nature must be such that it is likely to result in a useful contribution to technological knowledge and that, like the Council's first award, it requires industrial experience and academic study extending over a substantial period. The Council suggest that a three-year period of work would cover their requirements, provided it can be arranged for a high proportion of a student's time to be devoted to the programme of work proposed. The Council hope that employers will readily see the advantage of sponsoring such investigations and give students time for them.

Registration of candidates will not be restricted to holders of a Diploma in Technology, but may be extended to holders of equivalent qualifications. Teachers in technical colleges will be encouraged to become candidates for the award.

The student's work must be supervised by a staff member of the technical college at which it is undertaken and by a staff member of the industrial organisation concerned.

The technical college concerned will be responsible for the examination of candidates seeking membership of The College of Technologists, subject to any general arrangements including the approval of external examiners, which may be prescribed by The College of Technologists.

The Council state that there may be cases where it would be more appropriate for a holder of the Diploma in Technology to pursue his studies at a university, and they are most gratified to know that the Committee of Vice-Chancellors and Principals has strongly recommended to universities in the United Kingdom that, in suitable cases, holders of the Diploma in Technology should be on the same footing as holders of first degrees when application for admission to courses of study for higher degrees are being considered.

"ELECTRONIC COMPUTERS AND THE PRODUCTION ENGINEER"

— concluded from page 84

longer term idle plant and other under-employed assets will be the final result.

3. With a given speed of collection, transmission and marshalling of information, there is an optimum size for a single enterprise.

   If this size is exceeded, the control no longer functions effectively and the effectiveness of such control is inversely proportional to any further expansion.

   It becomes necessary, therefore, to decentralise the organisation.

An increase in the speed of getting the relevant final results to management will mean that a larger group can be brought within the ambit of a single control.

It is believed, despite the many examples of decentralisation which were brought about by low efficiency in management information production, that the larger units are *potentially* more efficient than the smaller ones, and that the introduction of faster data processing and subsequent *data screening* will turn the potentiality into actuality.

institution notes

BIRMINGHAM GRADUATE SECTION'S 25th ANNIVERSARY

ALL members of the Institution will wish to join with the Council in warmly congratulating the Birmingham Graduate Section on having achieved their 25th anniversary. This was the first Graduate Section to be established by the Institution, and from the beginning has proved to be enthusiastic and progressive, showing consistent originality in planning their activities. An outstanding example of this was the promotion, in 1949, of the First National Conference for Graduates and Students; the Section also promoted the First Graduates' Representatives Conference.

The Section officially came into being in February, 1933, when the inaugural meeting was held at the Grand Hotel, Colmore Row, Birmingham, to hear a Paper on "The Training of the Production Engineer". Mr. G. A. Wood was the first Honorary Secretary, and Mr. D. A. Tilt the first President.

Since that date, the membership has grown to 285; Mr. Tilt, now an Associate Member, belongs to the Birmingham Senior Section. Mr. Wood has emigrated to South Africa. The present Chairman is Mr. D. J. White; and the Honorary Secretary is Mr. R. V. Whateley.

In the quarterly News Letter recently circulated to Birmingham Graduates, Mr. E. J. Lownes, the Section's Publicity Secretary, gives an interesting account of the formation and growth of the Section, and includes the following amusing (if somewhat nostalgic) reference :

> " The item " Cost of Suppers " appeared on the agenda for the March Committee Meeting in 1939; this was at the insistence of certain members who felt they had been exploited by the ——— Hotel, who had the audacity to charge 3s. 6d. per head for the Annual Supper. It was indignantly pointed out that at a similar function held sometime before at another hotel, a charge had been made of 2s. 6d. per head for a similar service, and the Committee felt this was quite high enough, and resolved that the former hotel be boycotted and that before any more suppers were arranged, firm quotations were to be obtained from competitive establishments."

More than a few members, now prominent in industry and in Institution affairs, have sprung from the Birmingham Graduate Section. One of these is Mr. J. M. Steer, Member, who has recently taken office as President of the Australian Council. Another is Mr. B. E. Stokes, Member, Chairman of the Section from 1952 - 1953. Mr. Stokes won the first Schofield Travel Scholarship, awarded in 1950, and is now Chairman of the Editorial Committee and a Member of Council.

The activities of the Birmingham Graduate Section over the past 25 years have resulted in the formation of a vigorous body of young production engineers, and have provided many opportunities for the exchange of ideas and information which have assuredly contributed in no small measure towards the industrial well-being of the country. Birmingham Graduates may indeed be congratulated on their clear demonstration, over the years, of the truth and aptness of the Institution's motto — *vires acquirit eundo* — " we gather strength as we go ".

The Annual Dinner-Dance of the Western Section, held on 20th November, 1958, at the Berkeley Cafe, Bristol, was as usual a most enjoyable and successful occasion. Among the distinguished guests the Section were pleased to welcome the President of the Institution, The Rt. Hon. the Earl of Halsbury, F.R.I.C., F.Inst.P., M.I.Prod.E.

COVER-TO-COVER TRANSLATION OF RUSSIAN PERIODICAL

The Production Engineering Research Association is now producing cover-to-cover translations of "Stanki i Instrument", one of Russia's leading technical journals. The English version, which will appear monthly under the title "Machines and Tooling", commenced publication with the January, 1959 issue.

"Machines and Tooling" covers research and development over a wide field of production, as well as improvements in equipment and methods based on operating experience. It is, therefore, of great interest to all concerned with the reduction of production costs and the design and use of production equipment. Some of the subjects dealt with in recent issues of the journal include:

- New Tool Design
- High Frequency Heating
- The Problems of Automation
- The Development of Ceramic Tooling for Metal Cutting
- Hydraulic Mechanisms
- Design of Broaches
- Research and Development on Hydraulic Follower Systems
- Nitriding Techniques
- Injection Presses for Plastics
- Chamfering Tool Head for Boring Machine
- Ultrasonics
- Bimetallic Components
- Valve Spring Selection
- Polishing Intricate Parts
- Speed Reducing Mechanisms
- Thread Rolling
- Analysis of Layouts for Automatic Lines
- Sprayed Coolants
- Moulding Presses
- Spark Erosion
- Hopper Loading Devices
- Surface Grinding
- Pneumatic-Hydraulic Mechanisms in Machine Construction
- Strength of Cutting Tools
- Automatic Lines with Overhead Conveyors
- Cutting Tool Vibration
- Self-braking or Stopping Mechanisms for Machines
- Barrel Polishing
- Waviness in Grinding

The subscription rates for "Machines and Tooling" are :-

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DIARY DATES FOR 1959

March 11th ... ... **The 1958 Viscount Nuffield Paper,** to be presented at the University of Birmingham.

Speaker: **Dr. N. P. Inglis,** Metals Division Research Director, Imperial Chemical Industries Limited.
Subject: **"The Production, Fabrication, Properties and Uses of Some of the Newer Metals"** (see Supplement to this Journal).

April 16th/17th ... **The Seventh Aircraft Production Conference, Southampton.** (See Supplement to this Journal.)

April 29th ... ... **The 1958 George Bray Memorial Lecture,** to be presented in London.

Speaker: **Mr. Mark Bogod,** Director, J. Lyons & Co. Ltd.
Subject: **"The Search for Productivity in a Food Industry."**

October 12th ... ... **The 1959 E. W. Hancock Paper,** to be presented in Bristol.

Speaker: **Mr. R. A. Banks,** Personnel Director, Imperial Chemical Industries Limited.
Subject: **"Human Relations in Industry."**

NEWS OF MEMBERS

Mr. E. H. Holder, Member, of the Ministry of Supply, London, has been seconded to R.O.F., Pakistan, in the capacity of Manager.

Mr. A. McDonald, Member, has been appointed Chief Standards Engineer at the Harmondsworth factory of Black & Decker Ltd. His appointment commenced on 1st December, 1958. Mr. McDonald is the Immediate Past Chairman of the Stoke-on-Trent Section of the Institution.

Mr. J. R. Widdowson, Member, has been appointed Research Engineer of Samuel Fox & Co. Ltd., Sheffield. Mr. Widdowson is a Corresponding Member of the Papers Committee.

Mr. T. B. Worth, Member, has been awarded the Insignia Award in Technology of the City and Guilds of London Institute. Mr. Worth, who is Head of the Production Engineering Department at the Birmingham College of Technology, serves on the Institution's Education Committee.

Mr. M. Ashworth, Associate Member, has relinquished his position of Chief Tool Engineer with the Churchill-Redman Machine Tool Co., Halifax, on his appointment as Development Engineer with Hardinge Machine Tools, Feltham, Middlesex.

Mr. Harold Bateman, Associate Member, has been appointed Technical Sales Engineer for H. W. Kearns & Co. Ltd., for North Derbyshire, Nottinghamshire, Lincolnshire and Yorkshire (except parts of the North Riding). Mr. Bateman recently represented Charles Churchill & Co. Ltd. in the North West.

Mr. P. H. Cooke, Associate Member, has joined the lecturing staff of the Canterbury Technical College.

Mr. George Kenyon, Associate Member, who has been attending the 13th course organised by the N.A.T.O. Defence College in Paris, has now resumed his duties as an Engineer I in the Directorate of Guided Weapons Production, Ministry of Supply.

Mr. R. H. Leaney, Associate Member, has relinquished his position as Assistant Lecturer at the Brighton Technical College and has taken up an appointment as Lecturer in Management Studies at the College of Technology, Portsmouth.

Mr. H. E. Martin-Leake, Associate Member, has recently relinquished his position with Tube Investments Ltd. and has taken up an appointment as Industrial Engineer to the Iranian Oil Refining Company at Abadan.

Mr. H. H. Slater, Associate Member, has been appointed Works Manager of The Dart Spring Co. Ltd., West Bromwich.

Mr. Kenneth Thewles, Associate Member, has recently taken up an appointment as Senior Lecturer in Production Engineering at Crawley College of Further Education, Crawley.

Mr. D. Cowper, Graduate, has recently qualified for a Diploma in Graduate Studies (Engineering Production and Management) from the University of Birmingham, and has taken up an appointment as a Personal Assistant to one of the Directors and as Secretary of the Works Suggestion Scheme of Guest, Keen & Nettlefolds (Midlands) Ltd.

Mr. H. Souster, Graduate, has relinquished his position as Planning Engineer with B.S.A. Tools Ltd., at their Machine Tool Division, Mackadown Lane, Birmingham, and has taken up the position of Estimating Engineer with S. Smith & Sons (England) Ltd., at their Motor Accessories Division in Witney, Oxfordshire.

UNIVERSITY OF BIRMINGHAM

INSTITUTE FOR ENGINEERING PRODUCTION

PRODUCTIVITY STUDY COURSES

DURING the first half of 1959, the series of short residential courses at this Institute is being amplified by the introduction of a number of new subjects. Arrangements have been made with leading authorities, both in this country and the United States, to act as visiting course tutors.

These new courses are indicated by an asterisk in the list below, and the names of the visiting course tutors are given in brackets.

Design of Industrial Experiments — *2 weeks, January 5th - 16th (M. H. Quenouille, London School of Economics).*
This course is designed to help in obtaining the maximum amount of information from the minimum amount of industrial experimentation, by means of the scientific design of the plan of experiments.

Predetermined Motion-Time Systems * — I (Methods-Time Measurement) — *3 weeks, January 19th - February 6th (D. Battle, H. B. Maynard & Co.).*
Predetermined motion-time systems enable the determination of operation times without the use of a stop-watch, and may be used to examine alternative methods of production before these have been installed. This is the first course in a short series which will run on the various systems which are available.

Linear Programming Applied to Operations Planning and Control * — *1 week, January 19th - 23rd (Professor E. H. Bowman, Massachusetts Institute of Technology).*
A description of some mathematical approaches to production planning problems which are being currently developed.

Statistical Quality Control — *2 weeks, February 9th - 20th.*
This course will give the general theory of control charts and acceptance sampling plans and will include some recent developments and research in the field of statistical quality control.

Work Design — An Experimental Course * — *2 weeks, February 23rd - March 6th (Professor Gerald Nadler, Washington University).*
The object of this course is to focus attention on the necessity and advisability of concentrating effort on the proper design of work once it has been introduced.

Organisation and Methods — *3 weeks, March 9th - 27th.*
The aim of the course is to introduce the subject of Organisation and Methods by discussion of some of the aspects in detail and by practice of the analytical techniques described. Clerical systems and procedures, organisational structure and management control are considered.

Production Planning and Control — *2 weeks, April 20th - May 1st.*
The course discusses methods of production planning and control and the application of systematic analysis to these functions, with a view to the improvement of organisational and productive efficiency.

Operational Research — *2 weeks, May 4th - 15th.*
This course deals with the application of scientific method, including statistical and mathematical techniques, to the analysis of industrial engineering and management problems at the policy forming level. It is designed to provide an insight into the organisation of specialist staff and the setting up of operational research teams.

Advanced Work Measurement * — *2 weeks, May 25th - June 5th (Professor Gerald Nadler, Washington University).*
A course designed for the supervisory specialist in work measurement, in which the problems of modern work measurement will be examined and ways of increasing its accuracy will be discussed.

Work Study — *2 weeks, June 8th - 19th.*
The course is designed to examine work study theory and research and its practical application to the more effective employment of existing equipment, material and personnel.

Predetermined Motion-Time Systems * — II (Work Factor) — *3 weeks, June 22nd - July 10th.*
The second in the series of courses on Predetermined Motion-Time Systems will deal with the Work Factor System.

Linear Programming — *1 week, July 6th - 10th.*
The course will give the basic theory of linear programming and will illustrate the translation of industrial problems concerning the use of limited resources into a mathematical model.

Industrial Engineering * — *2 weeks, July 13th - 17th (Course to be arranged with Dr. M. E. Mundel).*

Queueing Theory and Practice — *1 week, July 20th - 24th.*
The course deals with problems of congestion which arise when service to a number of units is derived from a common source. In cases where the need for service is not regular and predictable the cost of delays may be balanced against the cost of service.

Lectures are conducted on an informal basis, and are given by members of the University staff, by guest lecturers from other universities and by speakers from industry who will discuss their own experience of applying these techniques.

Fees for courses are 55 guineas per 2-week course, and 33 guineas per 1-week course, inclusive of residence.

Further details and course programmes may be obtained from: The Director, Institute for Engineering Production, 16 Norfolk Road, Birmingham, 15. Tel.: EDGbaston 0390.

NOTICE TO CANDIDATES FOR THE ASSOCIATE MEMBERSHIP EXAMINATIONS

GRADUATES and Students are reminded that the existing examination regulations will cease to operate at the conclusion of the May, 1959, Associate Membership examination. Thereafter, candidates will be required to qualify under the new examination regulations.

The following exceptions to the above apply to any candidate already a Graduate before 1st April, 1959:-

1. Candidates for the examination who have already passed or been exempted from Parts I and II and one subject from Part III will be allowed until 31st December, 1961, to complete Part III under the old regulations which require only two subjects in this Part. Thus, candidates having passed or been exempted from Industrial Administration could complete the Associate Membership examination requirements by taking (a) the Management of Production or (b) Work Study, from Part III and Part II (Group C) respectively, of the new examination.
2. Similarly, candidates having passed either Production Planning or Work Study under the old regulations will be considered to have satisfied the new regulations if they take Industrial Administration from the new examination prior to 31st December, 1961.
3. Candidates who have passed Parts I and II of the examination but who have not passed any subject from Part III by May, 1959, will be required to pass Part III under the new regulations.
4. Candidates for Part III subjects who are successful in one subject of Part III in the May, 1959, examinations may complete their Part III requirements under the old regulations until 31st December, 1961, as provided for in 1 and 2 above.
5. Students or Graduates who consider that their existing qualifications might afford them some exemptions from the Institution's examinations are advised to send their certificates to the Registrar of the Institution immediately.

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ADDITIONS

Bailey, Gerald B., and Presgrave, Ralph. "**Basic Motion Time Study.**" *New York, London, etc., McGraw-Hill,* 1958. 195 *pages. Diagrams.* 39*s.*

Here, according to the authors, are "the principles of work measurement and motion identification essential to a system of predetermined motion times aimed at universal application". Basic motion time study (or B.M.T.) has, it is claimed, unique elements which differentiate it from other systems of P.D.M.T. These are:-

1. "The units of movement to which time values are assigned must be completely and exclusively identifiable by verbal and numerical description."
2. "The units must each be amenable to segregation both in description and time. That is to say, end points of adjoining motions must be precise and easily recognised."
3. "The assignment of time must be such that the total of component times will give the correct time for the operation in question, which means that correction factors must be recognised."

This is a "how-to-do-it" book, but knowledge of conventional time study is necessary and of other systems of P.D.M.T. is necessary before it can be appreciated, and before the B.M.T. system can be practised.

British Productivity Council, London. "**Cutting Costs for Productivity.**" *London, the Council,* 1958. 76 *pages. Diagrams.* 5*s.*

Edited versions of the Papers presented at the B.P.C. Conference, 1958 Factory Equipment Exhibition. The Papers were divided into the following groups: Work Study — Costing — Variety Reduction and Quality Control — Shift Work — The Team Approach.

Butzko, Robert L. "**Plastic Sheet Forming.**" *New York, Reinhold; London, Chapman & Hall,* 1958. 181 *pages. Illustrated. Diagrams.* 30*s.* (Reinhold Plastics Applications Series.)

This series is semi-technical in the sense that the reader does not need to be a chemist in order to understand the various volumes. The contents of this volume include chapters on the applications of sheet forming, on materials selection, mould design, machinery and other equipment, and on production costs.

Chief Inspector of Factories. "**Annual Report of the Chief Inspector of Factories on Industrial Health for the Year 1957.**" (Ministry of Labour and National Service.) *London, H.M.S.O.,* 1958. 50 *pages. Cmnd* 558. 3*s.*

Department of Industrial and Scientific Research. "**Mechanical Engineering Research, 1957.**" Report of the Mechanical Engineering Research Board, with the Report of the Director of Mechanical Engineering Research. *London, H.M.S.O.,* 1958. 63 *pages. Illustrated.* 4*s.* 6*d.*

Gloucestershire Industrial Education Council. "**Report on Conference Between Schools and Industry.**" *Cheltenham, 21st - 22nd October,* 1958. 107 *pages.* 5*s.*

About 200 teachers and industrialists attended the Conference. The first day's speakers were headmasters and headmistresses from a variety of Gloucestershire schools who spoke on: "What Gloucestershire Schools Have to Offer Industry". The second day's speakers were industrialists who spoke on "The Implications of New Technological Developments" — of the opportunities provided by industry to school leavers.

Gotlieb, C. C., and Hume, J. N. P. "**High-speed Data Processing.**" *New York, London, etc., McGraw-Hill,* 1958. 338 *pages. Diagrams.* 74*s.*

The book deals with the principles and techniques of processing data at high speed, including the representation of information, programming, coding, machine organisation and automatic programming. A hypothetical machine — a synthesis of several existing machines — is used to demonstrate the advantages and limitations of data processing equipment, and in examples of codes and programmes. The 52 problems at the end of the book include programmes to be written for the hypothetical machine, and some calculations to be made in binary arithmetic. The appendices comprise:

1. A tabular summary of the characteristics of nine actual processing machines, from various manufacturers.
2. A description of binary arithmetic.
3. A code summary for the hypothetical machine.

The applications discussed with examples are: insurance applications, accountancy applications, and planning and scheduling applications.

Gregory, Edwin, and Simons, Eric N. "**The Heat Treatment of Steel.**" (Second edition.) *London, Pitman,* 1958. 381 *pages. Illustrated. Diagrams.* 35*s.*

A comprehensive textbook on the subject. Since the first (1944) edition there have been important developments, especially in austempering, martempering, sub-zero treatment, and in the steels demanded by the plastics industry. These developments are summarised in new chapters. Other sections have been re-written or amplified.

Hardy, H. W. "**Jig and Fixture Details and Units.**" (Selected for the guidance of jig and fixture designers, and production engineering students.) *Brighton and London, Machinery Publishing Co. Ltd.,* 1958. 172 *pages. Diagrams. Tables.* (Machinery's Standard Reference Series.)

"Compiled for the guidance of the young jig and fixture draughtsman, in the practical design and proportioning of many details and units, most used in jig and fixture construction. It has been assumed that he already possesses a good general knowledge of the nomenclature, essential features and details adopted in the design and construction of jigs and fixtures . . ."

Immer, John R. "**Profitable Small Plant Layout.**" *Washington, D.C., Small Business Administration,* 1958. 48 *pages. Diagrams.* (Small Business Management Series, No. 21.) 25*c.*

An elementary account of the principles and practice of planning and making a layout.

Institute of Industrial Supervisors, Birmingham. "**Report Writing.**" Compiled by a Joint Committee of the West Midlands Group of the British Association for Commercial and Industrial Education; Presentation of Technical Information, Midland Group; Midland T.W.I. Association; Department of Industrial Administration, College of Technology, Birmingham. *Birmingham, the Institute,* 1958. 24 *pages. Illustrated.* 2*s.*

A very simple exposition of the subject, which clearly covers all the important points.

Institution of Metallurgists, London. **" Effect of Surface on the Behaviour of Metals " :** lectures delivered at the Institution of Metallurgists Refresher Course, 1957. *London, Iliffe & Sons; New York, Philosophical Library, for the Institution,* 1958. 100 *pages. Illustrated. Diagrams.* 21*s.*

Contents: Bailey, G. L. J. Methods of preparation and examination of surfaces — Hoar, T. P. Influence of surface treatments on the chemical behaviour of metals — Barwell, F. T. Relationship between surface condition friction and wear — Stephens, R. W. B. Influence of surface on the physical properties of metals.

North London Productivity Committee. **" Conference on Production Control, London, 1958."** *London, the Committee, in association with the British Productivity Council,* 1958. 54 *pages. Mimeo.*

Contents: Production control: a customer service (F. E. Pearce) — Reduction of variety: an aid to production control (R. S. Geoghegan)—Streamlining of small quantity complex production (H. Bud) — Flow production (R. J. Mann) — Computers in the service of production control (D. L. Johnston).

Office Management Association, London. **" The Control of Quality in the Office."** A Report produced by an Organisation and Methods Study Group of the Office Management Association. *London, the Association,* 1958. 36 *pages. Diagrams.* 9s.

Methods of inspection, of recording errors and reducing them discussed. Appendix A describes the use of sampling methods in checking clerical work.

Singer Charles, and others (editors). **" A History of Technology."** Edited by Charles Singer, E. J. Homyard and A. R. Hall. Five volumes. *Oxford, Clarendon Press,* 1954 - 1958. *Plates, Illustrated. Diagrams.* £8 8*s.* 0*d. per volume.* Vol. 1: From early times to the fall of ancient empires — 1954, 827 pages. Vol. 2: The Mediterranean civilisations and the Middle Ages — 1956, 802 pages. Vol. 3: From the Renaissance to the Industrial Revolution, c 1500 - c 1750 — 1957, 766 pages. Vol. 4: The Industrial Revolution, c 1750 - c 1850 — 1958, 728 pages. Vol. 5: The late nineteenth century, c 1850 - c 1900 — 1958, 888 pages.

Technology, or, as it used to be called "applied science", is even today barely recognisable as an integral subject: a random selection from this history might include sections on building construction, machine tools, calendar making, cartography, printing, and petrol engines. A history of technology can be written as a series of highly specialised histories, each understandable by the subject specialist only; or it can be written so that any reader willing to concentrate can understand it all. The editors have chosen the latter method and the value of the work lies not so much in the new material presented to the specialist — supposing him to be familiar with the history of his subject — as in the insight it can give him into the history of technologies other than his own, and into the relationships between the several technologies. This last quality is, to some extent, accidental, since little attempt is made to indicate the inter-action of the different technologies, the sections on which have been written separately by authorities on the subjects. However, this is a small fault, and is probably irremediable in a work of this extent. The material is in any case there for anybody who looks for it. There are numerous plates, other excellent illustrations, and bibliographies.

The first three volumes have already been noticed in the Journal. The contents of the last two are as follows: *Vol.* 4 — *The Industrial Revolution.* Agriculture — Fish preservation — Metal and coal mining — Extraction and production of metals — Power to 1850 — The steam engine to 1830 — Watermills, 1500 - 1850 — The chemical industry — Gas for light and heat — The textile industry — Ceramics — Glass — Precision mechanics — Machine tools — Building and civil engineering — Sanitary engineering — Roads — Canals — Shipbuilding — Cartography — Dredging — Telegraphy — The beginning of the change from craft mystery to science as a basis for technology. *Vol.* 5 — *The Late Ninetennth Century.* Food production — Management and preservation of food — The steel industry — New extraction processes for metals — Petroleum — The Stationary steam engine — The Marine steam engine — Internal combustion engines — The generation of electricity — The distribution and utilisation of electricity — Heavy chemicals — Dyestuffs — Explosives — Railway engineering — Shipbuilding — Aeronautics — Mechanical road vehicles — Cartography and aids to navigation — Building materials and techniques — Bridges and tunnels — Hydraulic engineering — Water supply — The textile industry — The working of metals — Machine tools — Ceramics — Glass technology — Printing and related trades — The photographic arts — Production and utilisation of rubber — Education for an age of technology — Technology and industrial organisation — Technology and its social consequences.

Singer, T. E. R. (editor). **" Information and Communication Practice in Industry."** *New York, Reinhold; London, Chapman and Hall,* 1958. 304 *pages. Illustrated. Diagrams.*

A manual of the collection, recording, and dissemination of technical and scientific information in industry. Each chapter provides an introduction to the subject treated, and concludes with a list of references for further reading. Most of the references and all the equipment described and illustrated are American but this should not invalidate the book for English readers. Contents: The industrial Information Department — The role of the information-service group in internal communications — Linguistics, language and terminology — Operations research and the technical information programme — The theory and practice of technical classification — Chemical research file departments as information services — The organisation of classified patent collections — Patent searching — Mechanical aids in the effective presentation of technical papers — Punched card methods applied to information retrieval — The technical translator in industrial research — Technical illustration — Technical writing — Editing technical reports — Some fundamentals of designing tables of data — Training the literature scientist — Indexing — Abstracting — Appendix: The newly developed benzine ring typewriter — Chemical typing made easy.

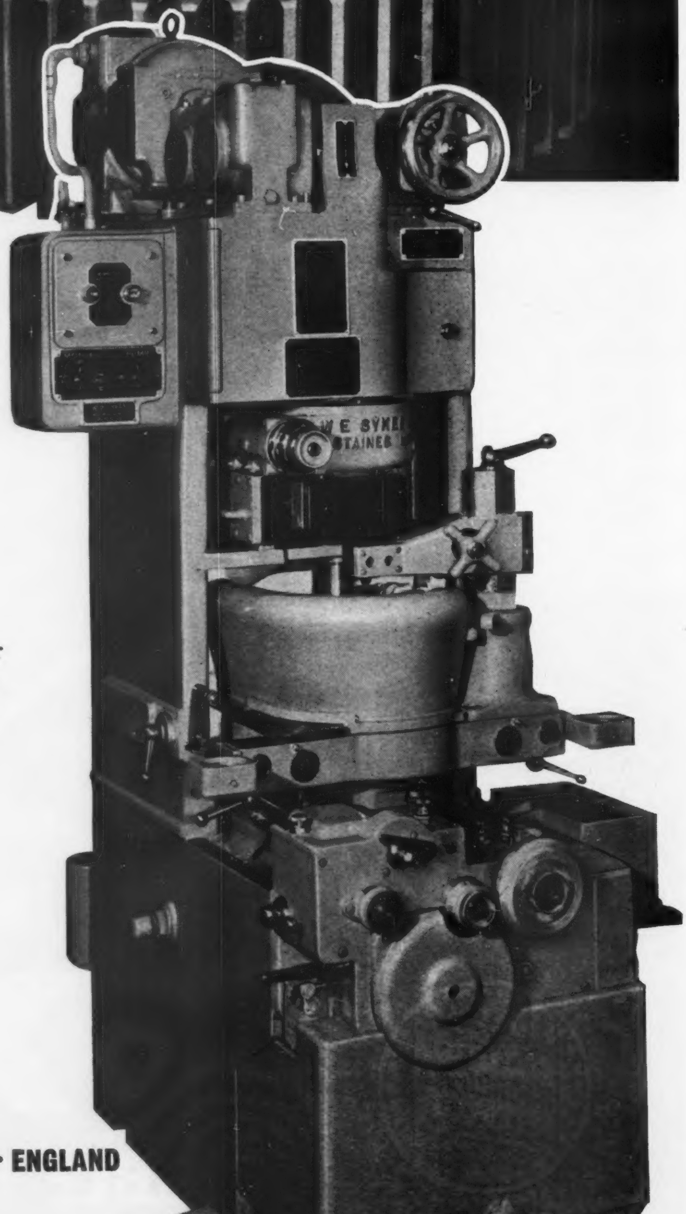
Society of Instrument Technology, London. **" Automatic Measurement of Quality in Process Plants " :** proceedings of a conference held at Swansea, 1957. *London, Butterworths Scientific Publications,* 1958. 320 *pages. Illustrated. Diagrams.* 50*s.*

The Papers presented are divided into the following groups:-

1. The adaptation of laboratory techniques to plant measurement.
2. Some techniques of gas stream analysis.
3. Liquid stream analysis.
4. Spectromotric methods.
5. Some new techniques for fluid stream analysis.
6. Measurement of some physical properties.

Watts, J. L. **" Electrical Maintenance and Repairs."** *London, Cleaver-Hume Press,* 1958. 324 *pages. Illustrated. Diagrams.* 21*s.*

A manual of routine inspection and fault location of electrical plant. Includes chapters on the maintenance engineer's duties, and on workshop stores and records.



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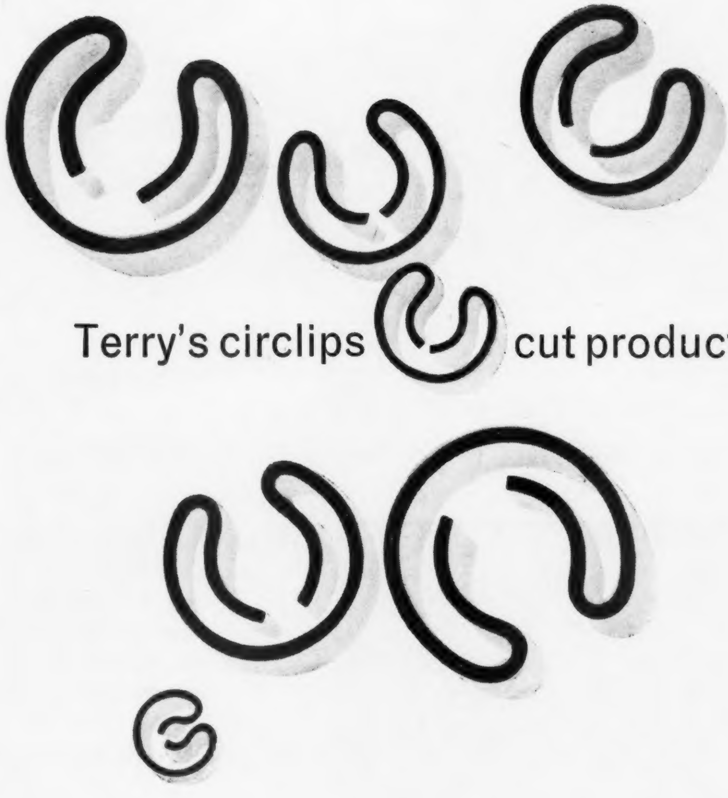
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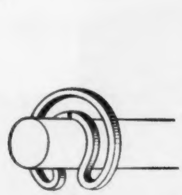

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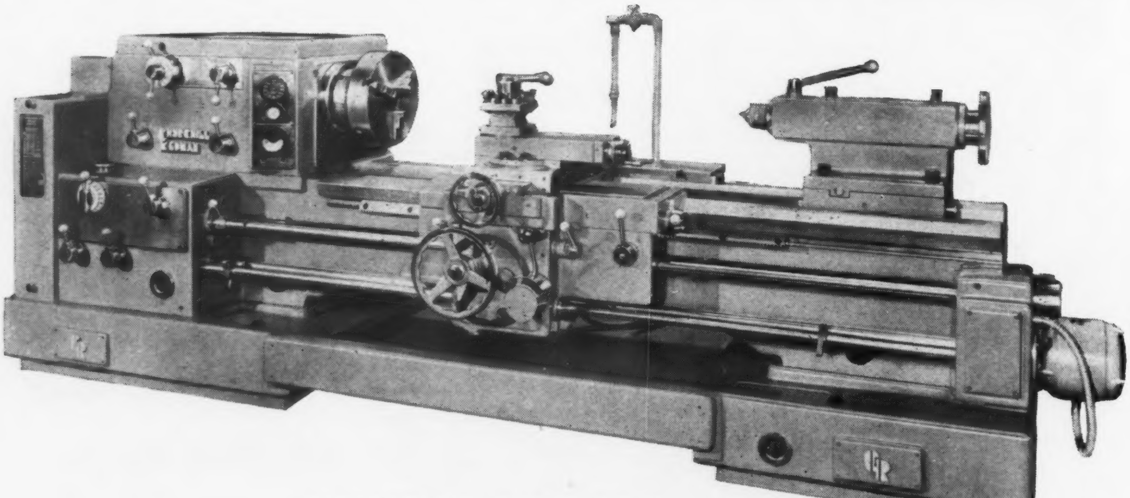

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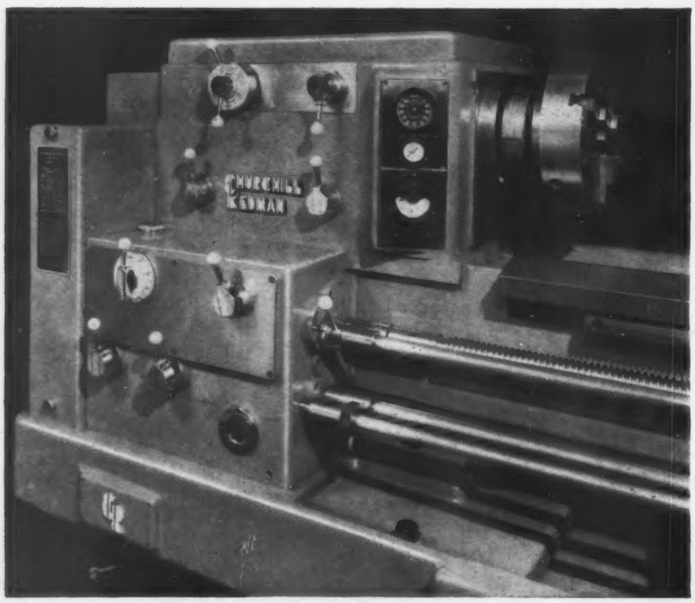

Close-up of the headstock and gearbox on 22L Model

18 Headstock spindle speeds
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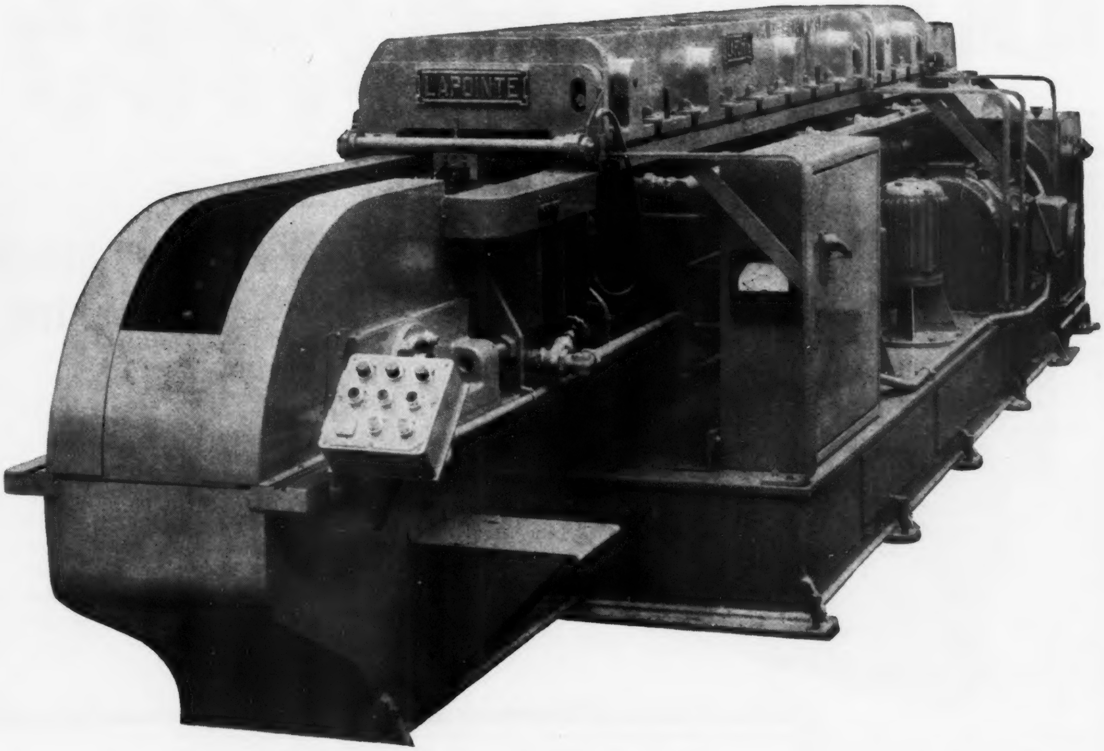


Electrical Aids in Industry *Data Sheet* **No. 3**

Induction Heating - 2

The broad principles involved in the use of induction heating for melting and processing metals have already been dealt with in this series (Data Sheet No. 2). In order to make a critical examination of its possibilities, however, the potential user should be aware of certain technical factors which must influence his decisions.

Induction heating, of course, demands the use of alternating current which is available from the public supply at a frequency of 50 cycles per second. Higher frequencies, however, are desirable for certain applications and can be obtained by means of the appropriate conversion equipment. Frequencies can therefore be considered in three categories:

Mains Frequency
(direct from mains)—50 c.p.s.

Medium Frequency
(machine generator)—50-10,000 c.p.s.

High Frequency
(electronic generator)—up to about 2,000,000 c.p.s.

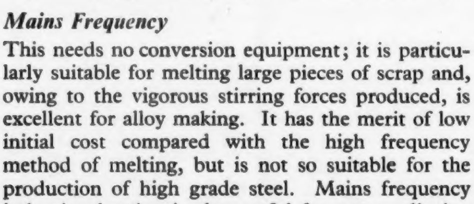
Mains Frequency

This needs no conversion equipment; it is particularly suitable for melting large pieces of scrap and, owing to the vigorous stirring forces produced, is excellent for alloy making. It has the merit of low initial cost compared with the high frequency method of melting, but is not so suitable for the production of high grade steel. Mains frequency induction heating is also useful for stress-relieving of welds in pipes and vessels, heating of chemical vessels, pipelines, injection moulding machines and press platens.

A typical example of the use of mains frequency is the coreless induction melting furnace which can be connected direct to the public 3-phase supply. Such a furnace rated at 120 kW, with a holding capacity of 2,240 lb., will give a throughput of 5,000 lb. per hour of hot cupola metal superheated from 1,350°C to 1,450°C.

Medium Frequency

Motor generators ranging from 10 kW to 1,500 kW or more at frequencies up to about 10,000 c.p.s. are widely used for heating for forging, melting from 100 lb. to 10 tons, hardening, annealing, etc. A bank of capacitors maintains a high power factor during the heating cycle.



Another form of generator for frequencies of 1 to 2 kc.p.s. and powers around 250 kW, useful for forge heating and melting high temperature aircraft alloys, is a 6-anode steel tank mercury arc inverter.

High Frequency

Metal hardening and metallurgical processing are best handled by high frequency induction (up to about 2,000,000 c.p.s.), particularly when a very thin case is required or when the section of the workpiece is too small to heat satisfactorily at medium frequency. These high frequencies are produced either by an electronic h.f. generator or a mercury-gap h.f. generator; high frequency induction can deal efficiently with such jobs as hardening lawnmower cylinders and cutters, bars and axle shafts.

The choice of frequency depends upon the metallurgical requirements and the size of the component to be treated. The following table gives the practical relationship between size and frequency, and may be used as a guide to the choice of generator, subject to metallurgical considerations.

Optimum Value

FREQUENCY C.P.S.	3,000	10,000	500,000	2,000,000
MIN. DEPTH OF HARDNESS POSSIBLE	.060 in.	.040 in.	.020 in.	.010 in.

Practical Values

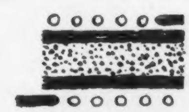
MIN. DEPTH HARDNESS EXPECTED	.150-.200 in.	.100-.150 in.	.030-.050 in.	.015-.030 in.
MIN. DIA. SURFACE HARDENING THIN CASE	2" & over	1" to 3"	½" to 2"	¼" to ½"
MIN. DIA. SURFACE HARDENING DEEP CASE	2" & over	2" & over	1" & over	not suitable
MIN. DIA. THROUGH HARDENING	1" & over	½" to 2"	¼" to ¾"	not suitable

These are of course very approximate since they also depend on metallurgical considerations.

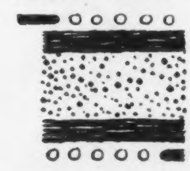
Power required for H.F. Induction Hardening

The high frequency power required per sq. in. of hardened surface depends upon the amount of metal behind the surface. Higher powers and shorter heating cycles are necessary for thin cases and when the thickness of metal behind the surface is small.

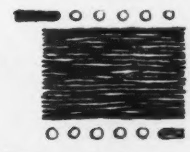
0.03" to 0.04" requires 1 sec. or less at 10 kW or more per sq. in.



0.1" to 0.2" with a large mass of metal behind the surface, requires 10-60 secs. at 2 kW per sq. in.



Through hardening requires 10-12 kWh per lb.

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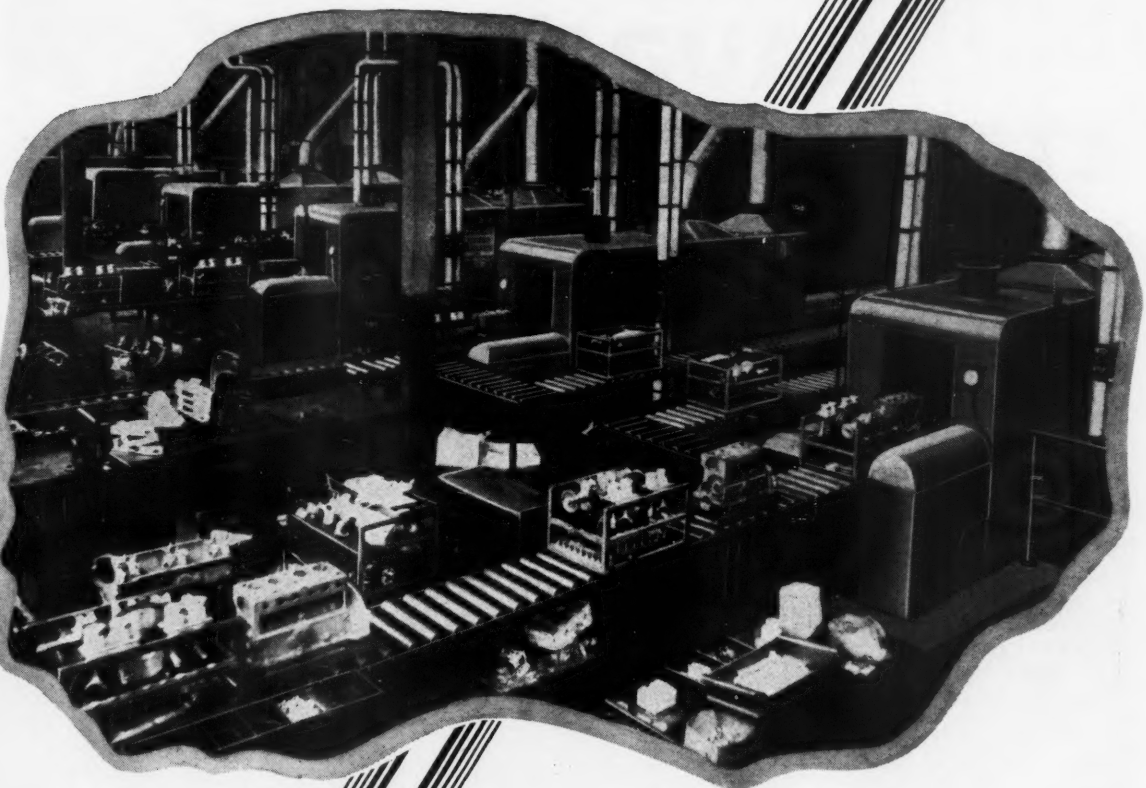
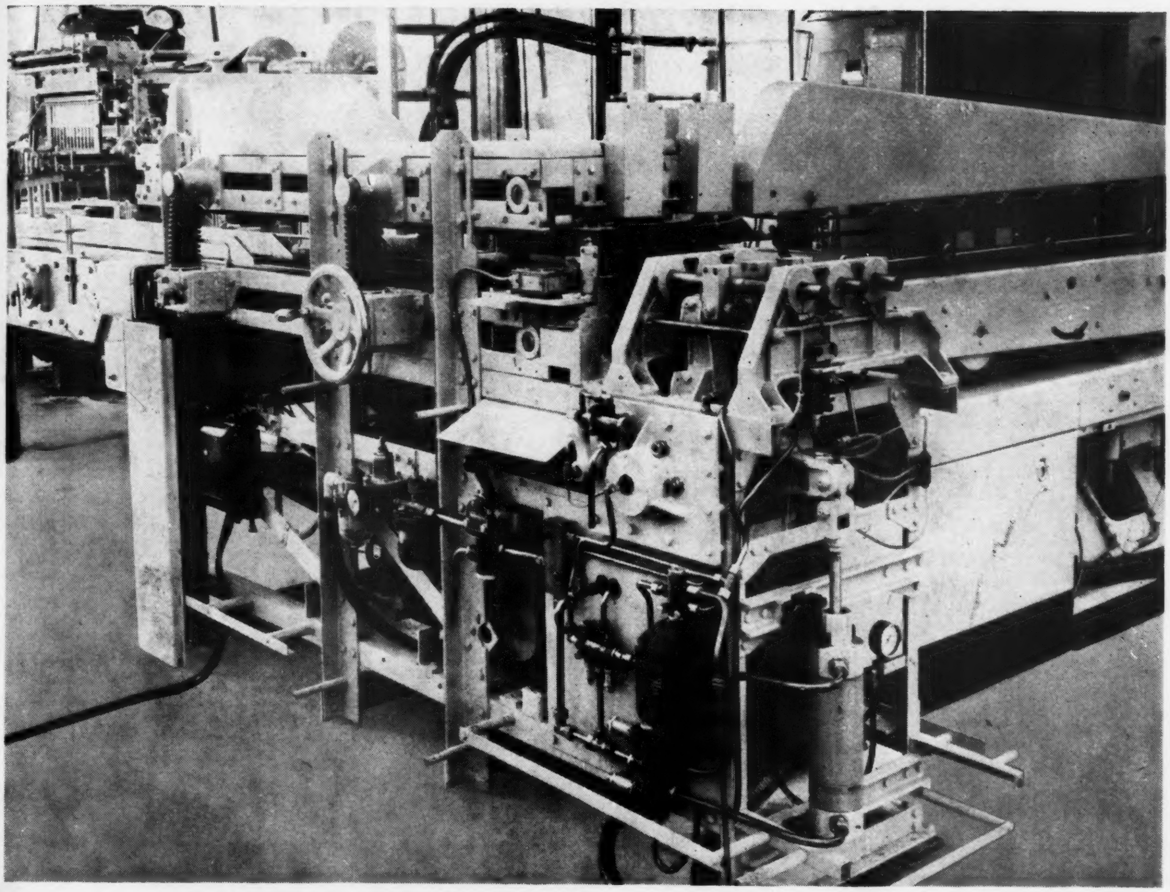
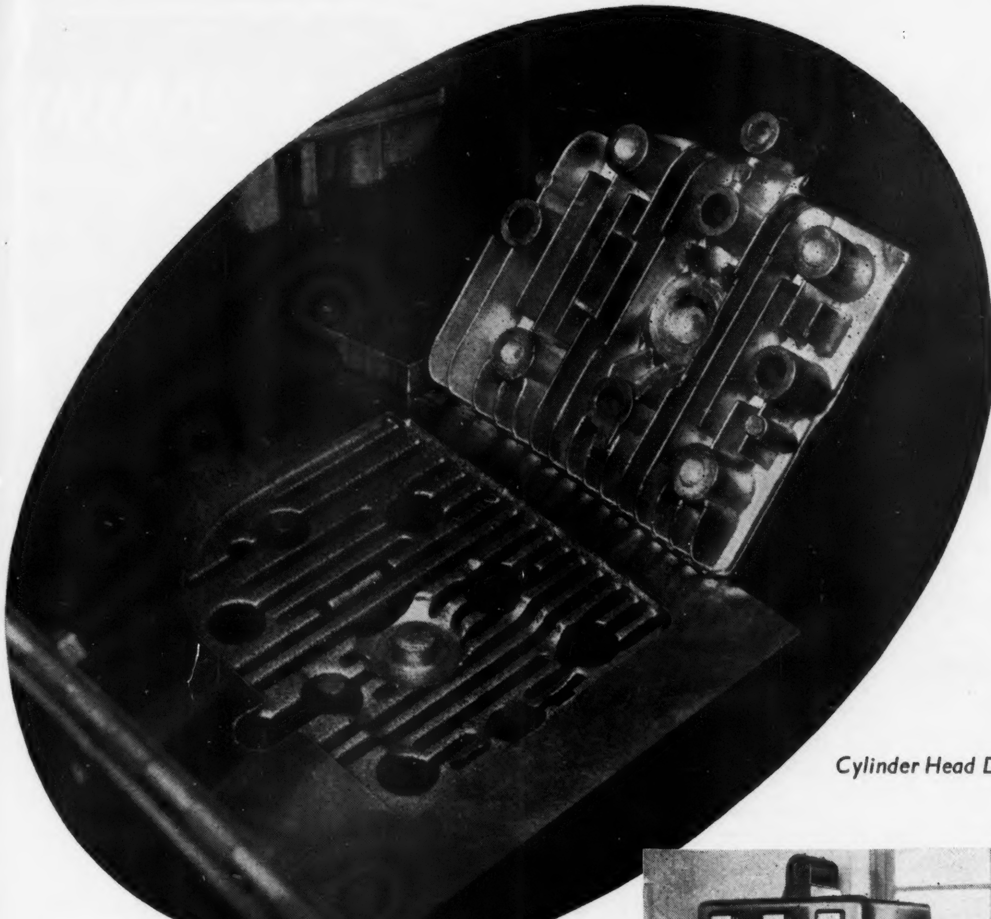
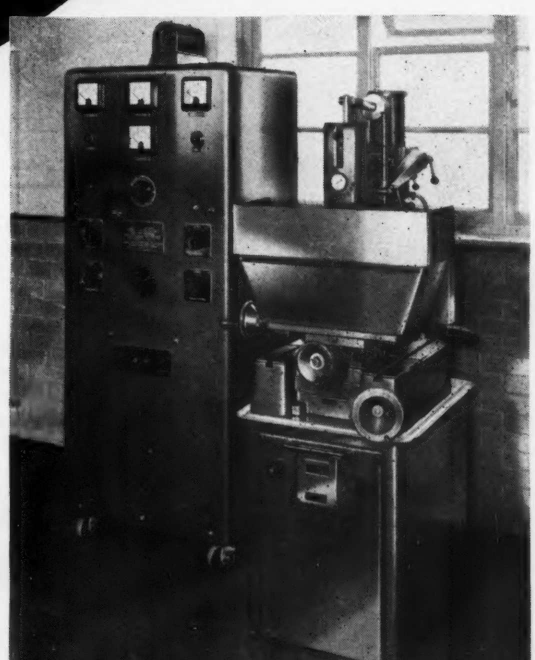






Cylinder Head Die



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